Are Reference Nutrient Intakes for key micronutrients and macronutrients set by COMA (1991) met and are their importance understood among pregnant women, attending antenatal clinics in Liverpool.

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Abstract

Introduction: The aim of this project was to investigate if intakes of key micronutrients and macronutrients during pregnancy reflect the understanding of specific micronutrients and macronutrients. The study further hypothesised if age, marital status, occupation, trimester of pregnancy, number of previous pregnancies and smoking affects total micronutrient and macronutrient intake and affects understanding of key micronutrients and macronutrients.

Design: A prospective observational study.

Subjects and methods: Pregnant women (n=47) were recruited from 3 different antenatal classes across Merseyside, UK. Subjects completed a non validated questionnaire and 3 day food diary. Questionnaires were analysed using SPSS and intakes were analysed using dietary analysis software.

Results: Occupation had a significant positive influence on dietary micronutrient intakes (p=0.004). Occupation had further affects on nutritional knowledge (p=0.009). Other significant differences were established between trimester and mean dietary intakes (p=0.008). The majority of mean intakes of micronutrients and macronutrients were lower than UK recommendations set by COMA (1991) for pregnant women.

Conclusion: It was concluded from this study that intakes of key micronutrients and macronutrients during pregnancy did not reflect the understanding of specific micronutrients and macronutrients. The participants from this study possessed a sound understanding of food sources for the different micronutrients and macronutrients. However it appears that this did not influence dietary intake, as RNIs in general were lower than recommended.

Declaration of original work

"I hereby declare that work contained here with is original and entirely my own work (unless stated otherwise). It has not been previously submitted in support of a degree, qualification or other course."

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BMD Bone Mineral Density

CI Confidence Interval

COMA Committee on Medical Aspects

Cm Centimetre

DHA Docosahexaenoic Acid

DRV Dietary Reference Value

EPA Eicosapentaenoic Acid

FFQ Food Frequency questionnaire

FSA Food Standards Agency

Kg Kilogram

LBW Low Birth Weight

LC n-3 PUFA Long-Chain n-3 Polyunsaturated Fatty Acids

LRNI Lower Reference Nutrient Intake

Mg/day Milligrams per day

N-3 fatty acids Omega 3 fatty acids

NDNS National Diet and Nutrition Survey

Ng/ml Nanograms per millilitre

NTD Neural Tube Defects

RCT Randomised Control Trial

RDA Recommended Daily Allowance

RNI Reference Nutrient Intake

RR Relative Risk

S.D. Standard Deviation

SPSS Statistical Package for Social Sciences

UK United Kingdom

UL Upper level

USA United States of America

µg/**day** Micrograms per day

1.0 Introduction

1.1 Why is micronutrient and macronutrient intake important for pregnancy?

Adequate nutrition is of extreme importance for health, especially during preconception and pregnancy and is highly beneficial to foetal and infant health. Sufficient nutrition from various micronutrients and macronutrients throughout pregnancy is increasingly being recognised as an important underlying determinant of pregnancy outcomes by lowering the possibility of Low Birth Weight (LBW) babies and reducing the risk of preterm babies (Ramakrishnan et al, 1999; Black, 2007; Zimmerman, 2009).

Furthermore, it is increasingly believed nutrition not only plays a vital role during infancy but can influence health during childhood and adulthood (Anderson, 2001 & Barker et al., 2003). Barker et al. (2003) claimed babies who have a LBW and were small during infancy had an increased risk of developing Cardiovascular Disease (CVD) and non insulin dependent diabetes in adulthood, which may be passed on to future generations. This is further supported by Rose (2010), who explains obese women during pregnancy increase their offspring's chance of developing CVD and becoming obese even if they are born without a LBW.

During pregnancy, metabolic demands are increased as a result of physiological and hormonal changes in the mother and growth of the foetus (Black, 2007). During this period, micronutrient and macronutrient deficiencies may have serious consequences for pregnancy outcomes. Gaining this understanding is complicated as micronutrient deficiencies often co-exist, and some deficiencies of minerals and vitamins differ according to age, season e.g. vitamin D status, ethnic group, and social class (Ramakrishnan et al.1999). Ramakrishnan et al. (1999) suggested "variability is due to dietary intakes with differing content and bioavailability of micronutrients and differing losses and requirements for micronutrients".

To date, the majority of studies have investigated individual vitamins or minerals and their effects on pregnancy outcomes. Therefore this study will investigate calcium, iodine, iron, zinc, folic acid, vitamin A, vitamin C and Omega-3 (n-3) fatty acids. These micronutrient and macronutrient deficiencies have been associated with possible birth defects and therefore are particularly important but have rarely all been investigated in one study.

The Reference Nutrient Intakes (RNI) for micronutrients in this present study are those set by the Committee on Medical Aspects [COMA] (1991). The RNIs set by COMA are used by government bodies such as, Department of Health and the Food Standards Agency (FSA). COMA (1991) RNIs are further used in national surveys such as the National Diet and Nutrition Survey (NDNS), in order to compare consumption of the public to the RNIs, to understand general intakes across the population and to detect percentage of deficiencies etc. COMA (1991) RNIs in this study are those adapted especially for pregnant women and which often differ to those set for women aged 19 – 50 years, as shown in table 1.1.

1.2 Calcium

Calcium intake is important during pregnancy as the developing foetus needs calcium to construct strong bones and teeth, to grow a strong heart with a healthy rhythm and to develop healthy nerves, and muscles. Calcium further aids in blood-clotting (Anthony, Costello & Osrin, 2003). When calcium intake is not sufficient from the diet, the foetus will extract calcium from the mother's bones (Olausson et al, 2008).

Calcium intakes in general across the UK are lower than the RNI of 700mg/day especially in females aged 19 – 25 years (COMA, 1991), shown in table 1.1. This is due to a restrictive diet where calcium tends to be avoided as it comes from 'fattening' dairy sources (Kadilkar et al, 2007). RNIs for calcium are based on the amount of

calcium required for bone formation, minimised bone resorption and retention of calcium (COMA, 1998).

Calcium deficiency during pregnancy may be associated with complications at childbirth and foetal development with regards to bone strength and nerve functioning (Black, 2007). In a cross sectional study consisting of 450 healthy pregnant women almost two-thirds of the mothers (64.3%) took no supplements during pregnancy and had inadequate intakes of calcium compared with the RNI. The study concluded calcium deficient pregnant women were at higher risk of giving birth to pre term babies and babies with a LBW (P= 0.03) (Sabour et al, 2006). However the research did not analyse the influence of any other micronutrient intakes therefore it is difficult to conclude that LBW is solely due to calcium deficiency.

Table1.1 Comparison between RNI's set for pregnant and non pregnant women aged 19-50 years, based on COMA, 1991.

Minerals	**RNI pregnancy**	**RNI women (aged 19-50 years)**	**Increment**
Calcium	700 mg/day	700 mg/day	None
Iodine	140 µg/day	140 µg/day	None
Iron	14.8 mg/day	14.8 mg/day	None
Zinc	7.0 mg/day	7.0 mg/day	None
Vitamins			
Folate	300 µg/day	200 µg/day	+100 µg/day
Vitamin A	700 µg/day	600 µg/day	+100 µg/day
Vitamin C	50 mg/day	40 mg/day	+10 mg/day
Vitamin D	10 µg/day	0 µg/day	+10 µg/day

1.3 Iodine

The mineral iodine exerts great importance for a healthy pregnancy. Iodine forms part of the hormones thyoxine (T4) and triiodothyonine (T3), which are necessary for the maintenance of metabolic rate, cellular metabolism and integrity of connective tissue. In the foetus iodine is necessary for the development of the nervous system during the first 3 months of gestation (Department of Health, 1991).

The RNI for iodine in the UK is 140 µg/day for females aged 19 – 50 years (COMA, 1991). There is no increased requirement during pregnancy as the body utilises iodine more efficiently. In the UK intakes in females aged 19 – 50 years are below RNI with a mean intake of 130 µg/day; however this average intake does not lead to deficiency of iodine as it is higher than the Lower Reference Nutrient Intake [LRNI] ([NDNS, 2004).

Iodine deficiency causes maternal hypothyroxinemia, which affects pregnant women even in apparently iodine sufficient areas, and often goes unnoticed because L-thyroxin (T4) levels remain within the normal range, and thyroid-stimulating hormone (TSH) is not increased. Berbel et al (2007) explained how a mild hypothyroxinemia during pregnancy increases the risk of neurodevelopment abnormalities, and experimental data clearly demonstrate that it damages the cortical cytoarchitecture of the foetal brain, however much of this research has been conducted on rats and human studies are very limited (Berbel et al, 2007; Moleti et al, 2009; Escobar et al 2007).

Iodine deficiency during pregnancy is further associated with cretinism (Escobar et al 2007; Xue et al, 1994). A study carried out in China, investigating over 1000 pregnant women with iodine deficiency found that those who were given iodine supplements (400mg/day) in the first trimester reduced the risk of their child being born with cretinism than those given iodine supplements in the final trimester [p=0.008] (Xue et al, 1994). This study is the only one of its kind and further investigation is required.

1.4 Iron

Iron is an extremely important component of the diet especially during pregnancy, like all minerals, the body cannot synthesise the mineral therefore it must be consumed through diet or dietary supplements. Iron is required for the formation of haemoglobin in the erythrocytes cells, which transport oxygen around the body. A low haemoglobin concentration is defined as anaemia (<10g/dl). Anaemia is the most common nutrient deficiency in the developed and the developing world (World Health Organisation, 2007). The levels of erythrocytes increases by around 50% when pregnant (Noronha, Bhaduri, Vinod & Kamath, 2010; Allen, 2000). Iron is further required for normal energy metabolism, myglobin, collagen and to maintain a healthy immune system (Petroutsos et al, 2009).

The RNI for iron is based on the amount required to cover basal losses, menstrual losses and growth needs. The RNI for females over 19 years and pregnant women is 14.8mg/day (COMA, 1991). Iron requirements increase during pregnancy, to support foetal development, however the RNI for iron remains the same throughout gestation due to cessation of menstrual losses and due to mobilisatation of maternal stores and increased intestinal absorption (Whittaker & Lindl, 2007). According to the NDNS (2004), women aged 19 – 50 years in the UK are consuming a mean intake of 8.8mg/day of iron. This figure is higher than the LRNI of 8.0mg/day therefore in most cases will not result in anaemia.

Iron deficiency during pregnancy can have harmful effects on the foetus. Iron deficiency results in anaemia, which increases the risk of death from haemorrhage during delivery, but its effects on foetal development and birth outcomes is uncertain (Black, 2007). A large study including over 30,000 pregnant women, of which 16.7% had anaemia, found anaemic pregnant women without iron supplementation had a significantly shorter gestational age at delivery with a somewhat higher rate of preterm births but these adverse birth outcomes were prevented with iron supplementation (Relative Risk (RR)) 1.2 Confidence Interval [CI] (0.9–1.5). The rate of total congenital abnormalities were lower than expected and explained mainly by the healthier lifestyle and folic acid supplements (Bánhidy et al, 2009).

1.5 Zinc

Zinc is present in all tissues and is an essential component for many enzymes in which it has structural, regulatory and catalytic roles (Department of Health, 1991). Zinc is required for many proteins that are critically important in the processes that underlie embryonic development such as DNA and protein synthesis, mitosis and cell division

(Vallee & Falchuck, 1993). Zinc is furthermore essential for immune system functioning and maintains sense of smell and taste (Bhowmik, Chiranjib & Kumar, 2010).

In the UK the RNI for zinc in females aged 19 – 50 years and pregnant women is 7.0 mg/day (COMA, 1991). No increase is necessary during pregnancy as it is considered probable that in healthy women metabolic adaptation ensures an adequate transfer of zinc to the foetus (Badru et al, 2010). The NDNS (2004) indicate women aged 19 – 50 years are consuming an average of 6.8mg/day. This is 98% of the RNI therefore will not result in deficiency.

It has been suggested that low serum zinc levels may be associated with suboptimal outcomes of pregnancy such as prolonged labour, atonic postpartum haemorrhage, pregnancy-induced hypertension, preterm labour and post-term pregnancies, although many of these associations have not yet been established (Mahomed & Bhutta, 2007). To further investigate the suggestion Mahomed & Bhutta (2007) searched the Cochrane Pregnancy and Childbirth group's Trials Register for randomised or quasi-randomised trials of zinc supplementation in pregnancy. They included 17 Randomised Control Trials (RCTs) involving over 9000 women and their babies. Zinc supplementation resulted in a small but significant reduction in preterm birth (RR 0.86, 95% CI 0.76 to 0.98). This was accompanied by a similar reduction in numbers of babies with LBW (RR 0.84). Studies to address ways of improving the overall nutritional status of populations rather than focusing on micronutrient and or zinc supplementation in isolation, should be an urgent priority. However, much of this work was done in the presence of severe zinc deficiency. In marginal deficiency, no effects were seen on pregnancy outcome or foetal malformation, although there may be an association with preterm rupture of membranes (Carey et al, 2000).

1.6 Folic acid

Folate is a water-soluble, B-complex vitamin that serves as an essential coenzyme in single-carbon transfers in the metabolism of nucleic and amino acids and thus fills an important function in purine and pyrimidine metabolism (Cole, 2007). It occurs in certain natural foods as polyglutamate, a form less absorbed than free folate.

Folic acid is an essential vitamin, the body cannot synthesise folic acid therefore it must be consumed via diet or dietary supplements. Cole (2007) describes folic acid as the oxidized and most active form of the vitamin; found rarely in food, and is the form used in vitamin supplements and food fortification. The distinction between food folate and folic acid is important because of differing bioavailability; food folate is about half as bio available as folic acid consumed on an empty stomach (Cole et al 2007).

The RNI for folic acid is 300µg/day for pregnant women in the UK (COMA, 1991). This increase from 200µg/day for females aged 19 – 50 years is suggested to commence 3 months prior to conception (Department of Health, 1991); however, around 50% of pregnancies are unplanned in the UK (Mossey et al, 2009; Floyd & Hungerford, 1999). Average intakes reflect this uncertainty as many pregnant women are not consuming enough folic acid in their diets. The NDNS (2004) show females aged 19 – 50 years consume a mean intake 229mg/day. However dietary supplements are not taken into consideration (Bekker, 2009).

It is important to start taking folate supplements 3 months prior to conception as it greatly reduces the risk of Neural Tube Defects [NTD] (Scholl & Johnson, 2000; Pitkin, 2007). NTDs are abnormalities of the embryo's brain and spinal cord. The most common NTD is spina bifida, which can be mild or severe. In mild forms, babies are born with a dimple or tuft of hair at the base of the spine. In more serious forms, the vertebrae are abnormal or part of the spinal cord is open to the skin. Severe forms can

cause weakness or numbness in the legs and lack of bladder or bowel control (Watkins, 1996).

Pitkin (2007) carried out a meta-analysis on several different RCTs; the most significant RCT involved nearly 600 pregnant women randomised into a folate supplementation group (4.0mg/day) and a placebo group each begun 1 month before conception and continued through the first trimester, in a large number of women who had previously had NTD-affected pregnancies. There were 6 NTD cases among 593 supplemented women compared with 21 among 692 placebo control women, a risk reduction of 72%; among women known to have initiated folic acid before conception, risk was reduced by 83%.

Another RCT involving over 1000 women in Britain with previous NTD pregnancies were enrolled and the supplement was 0.36 mg folic acid plus multivitamins, begun 2 months before conception and continued through the first trimester. 3 NTD pregnancies occurred among 454 supplemented women compared with 24 among 519 un-supplemented women, a RR 0.14 (P=0.05). Although strongly suggestive, this report was not regarded as definitive because assignment to treatment groups was not random (British medical Research Council, 1991).

1.7 Vitamin A

Vitamin A is a fat-soluble vitamin stored in the liver. Retinol is the most active form of vitamin A. Vitamin A plays an important role in vision, bone growth, reproduction, cell division and differentiation (Debier & Larondelle, 2005). It maintains the surface linings of eye, respiratory, urinary, and intestinal tracts. Vitamin A aids lymphocytes, which help destroy harmful bacteria and help them function more effectively. It is required for development and maintenance of the epithelial cells, in the mucus membranes, and is

important in the storage of fat and synthesise of protein and glycogen (Chan et al, 2007).

Vitamin A is important for the foetus' embryonic growth – including the development of the heart, lungs, kidneys, eyes, and bones, and the circulatory, respiratory, and central nervous systems. (Chan et al, 2007). Vitamin A is particularly essential for women in their final trimester, as it helps with postpartum tissue repair (Chan et al 2007).

The RNI for vitamin A in the UK is 700 µg/day for pregnant women (COMA, 1991). Vitamin A deficiency is not a major issue in the UK even though the NDNS (2004) show on average women aged 19 – 50 years consume only 78% of the RNI this figure is above the LRNI.

Vitamin A deficiency is rare in the UK, however Lueng et al (2009) found that 47% of a small study group carried a genetic variation (beta-carotene 15,15 monoxygenase) which prevents beta-carotene carotene being metabolised into vitamin A, therefore were at significantly higher risk of becoming deficient in vitamin A ($p=0.025$). However, this was a very small volunteer study and cannot be representative of a population. Vitamin A deficiency throughout pregnancy has been shown to result in impaired vision of the infant due to a less developed retina and LBW babies (Radhika et al., 2002). The foetus grows rapidly in the final trimester therefore it is essential to ensure vitamin A recommendations are met through diet and or dietary supplements (Department of Health, 1991).

1.8 Vitamin C

Vitamin C intake is essential during pregnancy as it is needed for tissue repair, wound healing (by promoting lymphocyte production and because vitamin C aids in collagen production which is needed as a defence mechanisms against disease and infection), bone growth and repair (by promoting the production of erythrocytes in bone marrow).

Vitamin C also helps the body fight infection, and it acts as an antioxidant, protecting cells against damage from free radicals (Poston et al, 2006). Both mother and foetus require vitamin C in order for the body to make collagen a component of cartilage, tendons, bones, and skin. Vitamin C also helps the body absorb iron by increasing the amount of iron absorbed from the digestive tract (Sandstorm, 2001). One study reported that adding just 63 mg of vitamin C to a meal rich in non-haem iron significantly yielded a 2.9-fold increase in iron absorption (Fidler, 2009).

The RNI for vitamin C in the UK is 50mg/day for pregnant women (COMA, 1991). This is a 10mg/day increase from non pregnant women aged 19 – 50 years to accommodate for foetal development especially towards the final stages of pregnancy (Department of Health, 1991). The NDNS (2004) indicates on average women aged 19 – 50 years consume 67.9 mg/day of vitamin C; however this intake will not lead to toxicity as the figure is below the Upper Intake Level (UL) of 1000mg/day.

Vitamin C deficiency during pregnancy can be detrimental to both mother and foetus. Vitamin C deficiency has been linked to growth retardation and pre term births as well as less developed immune systems (Black, 2007). Vitamin C deficiencies have been associated with complications of pregnancy, but RCTs are needed to determine the true relationships (Ramakrishnan et al. 1999). One RCT involved 283 women who were identified as being at increased risk of pre-eclampsia by abnormal two-stage uterine-artery doppler analysis or a history of the disorder and were randomly assigned vitamin C (1000 mg/day) or placebo at 16–22 weeks' gestation. Pre-eclampsia was assessed by the development of proteinuric hypertension. The study found that provision of vitamins C resulted in a 21% ($p=0.015$) lower rate of preeclampsia, pregnancy induced hypertension (Chappell et al. 1999).

1.9 Vitamin D

Vitamin D is important to consume during pregnancy as it has long been recognised for its beneficial effects on bone health and more recently has been recognised for its important role in regulation of cell growth, immunity and metabolism, as vitamin D is present in nearly all cells and tissues in the body (Holick, 2006).

The growing foetus is reliant on maternal vitamin D status. The mother transports vitamin D as 25OHD, through the placenta. This demand is greatest during the final trimester of pregnancy when the foetus undergoes rapid growth (Molgaard & Fleischer, 2003).

The RNI for vitamin D in the UK, for pregnant women is 10 µg/day (COMA, 1991). This is a 10 µg/day increment compared to non pregnant women, aged 19 – 50 years in the UK. No RNI is necessary for adults, aged 18 – 65, living a normal lifestyle in the UK because plasma 25-OHD normally ranges from 15 ng/ml to 35 ng/ml in summer and 8 ng/ml to 18 ng/ml in winter, which is achievable via ultra violet exposure (Department of Health, 1991). COMA (1991), suggested that pregnant women should "receive supplementary vitamin D to achieve the RNI of 10 µg/day" (Hollis & Wagner, 2004). A study by Holmes et al. (2009) found that pregnant women taking vitamin D supplements (10 µg/day) had significantly higher plasma vitamin D status than pregnant women not taking supplements ($p=0.001$).

The NDNS show the mean intake of vitamin D among females aged 19 – 50 years is 2.3 µg/day in the UK, for non pregnant women this is adequate due to summer exposure to sunlight which provides sufficient vitamin D stores throughout winter (NDNS, 2004).

In the UK during the 1940s fortification of vitamin D was introduced to many foods, this was prompted due to the increase of the growing child developing rickets (Tulchinsky & Varavikova, 2009). Since this fortification vitamin D deficiency has become less

prevalent among Caucasians in the UK. However, levels of immigration are increasing and the prevalence of vitamin D deficiency, especially among Asian communities, is increasing (Roy et al., 2007). Populations with darker skin pigmentation are at greater risk of becoming deficient in vitamin D (Roy et al., 2007).

Vitamin D deficiency occurs when demand exceeds supply, this tends to occur during periods of rapid growth in foetal life, infancy, childhood, adolescence and during pregnancy and lactation (Department of Heath, 1991).Pregnant women with a low vitamin D deficiency ultimately give birth to infants with low vitamin D status, which drastically increases the probability of the infant developing rickets throughout childhood [$p<0.05$] (Molgaard & Fleischer, 2003).

The impact of vitamin D deficiency during pregnancy can have serious effects on maternal and foetus health. Bodnar et al. (2007) found a significant increased risk for preeclampsia when the mother was deficient in vitamin D ($p=0.004$). However the study further showed the risk of preeclampsia drastically decreased when participants were exposed to ultra violet light ($p<0.05$). However, this decrease was only significant among the African American population and no significant decrease was found for Caucasian women.

1.10 Omega 3 fatty acids

N-3 fatty acids exert vital effects on eicosanoid metabolism, membrane properties and gene expression by aiding with synthesise and functioning of the pathways and biological activity. Therefore these are very important nutrients to consume throughout pregnancy. This is especially true for the long chain n-3 polyunsaturated fatty acids docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), shown in figure 1.1. “DHA is a vital component of neural and retinol membranes and accumulates rapidly in the brain, enhancing brain development and helps the retinas form during the later part

of gestation and early post natal life" (Jenson, 2006). EPA and DHA work together and can be obtained from dietary lipids or can be synthesised from shorter chain fatty acids such as alpha linolenic acid (Freeman et al, 2006). Al et al. (1995) showed that DHA is transferred to the foetus throughout pregnancy and if maternal consumption of DHA is low, then the growing foetus will extract the necessary DHA from the mother's stores.

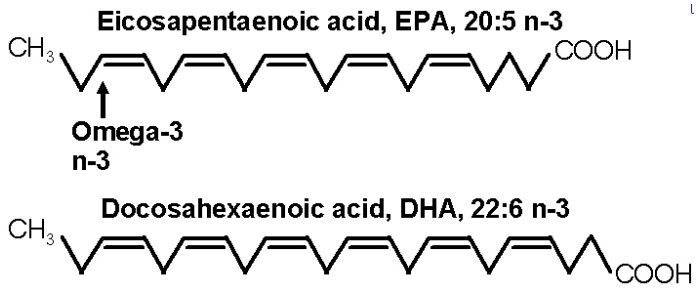

Figure 1.1 chemical structure of EPA and DHA (source: http://www.omega-3-forum.com/fattyacids.jpg&imgrefurl)

The biological activities of DHA and EPA have lead to the hypothesis that intakes might have significant effects on numerous pregnancy outcomes, including preterm birth, infant size at birth, preeclampsia, cognition, immunological functions such as development of the nervous system (Harper et al, 2010; Freeman et al, 2006). Harper et al (2010) conducted RCTs in 13 centres. Women with a history of prior preterm birth and a current gestation were assigned to either a daily n-3 (1,200 mg eicosapentaenoic acid and 800 mg docosahexaenoic acid) or a matching placebo from 16-22 through 36 weeks of gestation. 852 women were included. Delivery before 37 weeks of gestation occurred in 17.8% of women in the n-3 group and 41.6% in the placebo group (RR 1.10).

The International Society for the Study of Fatty Acids and Lipids [ISSFAL] (1991), recommend 300mg/day of n-3 fatty acids for pregnant women across Europe. COMA

(1991) do not have any set recommendations. Women aged 19 – 50 years in the UK are consuming an average of 180mg/day of n-3 fatty acids (NDNS, 2004) and consuming excess amounts of other type of fats such as saturated fats, which have been linked to detrimental health effects such as coronary heart disease, diabetes and hypertension (Department of Health, 1991).

N-3 fatty acids deficiency during pregnancy may result in the foetus utilising n-3 fatty acids from the mother's storage sites as the body cannot synthesise n-3 fatty acids (Singh, 2005; Van Houwelingen et al, 2007).

N-3 deficiencies during pregnancy may result in detrimental effects to the child's birth weight, visual and neurodevelopment outcomes. A study conducted in the UK by Malcom et al (2003) tested the hypothesis that the supplementation of the diets of pregnant women with a fish oil rich in DHA enhances retinal development in infants, as measured during the postnatal period. 100 participants were randomised to either fish oil (DHA= 200mg/day) or a placebo group (sunflower oil 323mg/day), from 15 weeks of pregnancy to delivery. The research found infants born of mothers who received supplements did not differ at birth in weight. However, a positive association between infant DHA status and maturity of the retina at birth was found to be significant ($p < 0.005$). These findings demonstrate an association between the DHA status of term infants and retinal sensitivity, suggesting an essential role of long-chain polyunsaturated fatty acids in the development and function of the retina. However this was only a small study (participants = 100), which was not representative of the population.

A Norwegian study by Helland et al (2003) randomly allocated 341 pregnant women into a cod liver oil supplementation group (10ml/day until 3 months after delivery) and a placebo group (10ml/day corn oil). The study followed the pregnant women up after 4 years and gave their children the Kaufman assessment battery test for children and

found that those children whose mothers received cod liver oil supplements performed significantly better on the tests ($p = 0.05$) (Helland et al, 2003).

1.11 Current awareness of the importance of micronutrients and macronutrients in the United Kingdom among pregnant women

Previous studies have found that during pregnancy women become more aware of the health aspects of nutrition, compared to the preconception period (Szwajcer et al., 2006 and Inskip et al., 2009). However, it is not totally clear if the knowledge gained regarding nutrition is put into practice and if women adjust their nutritional intakes to meet recommended amounts. A study carried out by Szwajcer et al in 2006 found that the majority of pregnant women had considered nutrition to some extent, such as asking about folic acid intake. However, as the pregnancy continued 43% of women decided to continue the same diet as before pregnancy and did not adjust intakes for certain micronutrients and macronutrients even though they were aware of their importance.

It is acknowledged that most women are aware of the strong evidence that preconception folic acid supplements greatly reduce the risk of NTD, however few act on this knowledge as increasingly more pregnancies are unplanned (Eichholzer et al., 2006). Furthermore many women are unaware of other vital micronutrients and macronutrients needed during pregnancy. Past studies have shown that in developed countries such as England, Australia and the United States of America, many women are under consuming and are unaware of the importance of certain micronutrients such as iodine (Charlton et al, 2010; Caron et al 1997). Charlton et al (2010) carried out a cross-sectional study conducted at antenatal clinics in Australia. 139 pregnant women across all trimesters provided a urine sample and completed a questionnaire. Only 14% had adequate iodine intakes and knowledge of the adverse health effects of an

inadequate iodine intake was poor. Approximately half the participants were able to indicate good dietary sources of iodine. Only 11% of participants reported they had intentionally changed their diet to increase iodine intake during pregnancy.

Awareness of zinc recommendations during pregnancy is not commonly known across the UK based on nutritional intake (NDNS, 2004). Research on the topic is limited and data is unavailable therefore knowledge of the importance of zinc needs to be investigated. On the other hand, awareness of the significance of iron intake during gestation is well documented for pregnant women, however many women still do not meet RNIs set by government bodies (World Health Organisation., 2007).

An investigation by Sinikovic et al (2009) evaluated pregnant women's knowledge regarding the importance of Long-Chain n-3 Polyunsaturated Fatty Acids (LC n-3 PUFA) consumption during pregnancy and assessed their views on current information availability. The results showed that 75% of women had not received information regarding LC n-3 PUFA. Approximately half of the women were aware of issues relating to LC n-3 PUFA; however, their knowledge was limited, with most obtaining their knowledge from websites and magazines. Women generally had low (30 %, 29 %) to moderate (28 %, 24 %) levels of concern about LC n-3 PUFA and mercury, respectively.

1.12 Differences in intakes of micronutrients and macronutrients among pregnant women in different social classes, age groups, number of previous pregnancies, different trimesters, marital status and smokers

1.12.1 Micronutrient and macronutrient intake and smoking

Smoking during pregnancy has shown to have adverse consequences, such as lowered mean birth weight and increased risk of preterm delivery (Haste et al 1990; Matthews et al, 2000; Sausenthalar et al 2007 & Lumley et al, 2009). Anti-smoking

campaigns in the UK has shown limited success, with cessation rates of 7-8% (Health Education Authority, 1994) and a significant number of pregnant women continue to smoke throughout gestation (Lumley et al 2009). In general past studies have shown smokers have a lower nutrient intake during pregnancy than smokers (Haste et al 1990; Matthews et al, 2000; Sausenthalar et al 2007). However no recent studies have been carried out in the UK therefore smokers may have improved nutrient intakes during pregnancy due to more awareness of the importance of a healthy diet (Liebert, 2007).

1.12.2 Micronutrient and macronutrient intake and age

Nutrient intake and age has been rarely investigated. Mathews et al (2000) concluded age is strongly associated with nutrient intake as 24 year olds had a lower mean intake vitamin C of 57mg and 28 year olds had a mean intake of vitamin C 106mg ($p<0.05$). Therefore young women and young women who smoked had the lowest nutrient intake compared to older and non smoking women. The study further found that younger women are at higher risk of iron, calcium and folate deficiency. This is the first study to establish young pregnant women as a group are at risk of low micronutrient intake. However this subject needs to be further investigated.

1.12.3 Micronutrient and macronutrient intake and occupation

Very few studies have investigated the relationship between occupation and micronutrient and macronutrient intake. Mathews et al. (2000) used occupation as a method for defining social class. Therefore social class can be a method for defining occupation as those with a higher skilled occupation tend to receive a higher income than those with a less skilled occupation.

Little research has explored income and diet quality during pregnancy (Rogers et al, 1998). However a common hypothesis is that social class predicts diet quality (Darmon

& Drenowski, 2008). In England the quality of a pregnant woman's diet tends to fall with income (Bull et al, 2003) and mothers from low-income households are nutritionally vulnerable and may go short of food in order to feed their children (Dobsen et al, 1994; Calvert & Dowler, 1995). A study conducted by Mouratidou et al (2006) found an association between pregnant women living in the most deprived areas of Sheffield, UK, had lower intakes of iron ($p=0.004$) and most of other micronutrients such as folate ($p=0.001$) and vitamin C ($p=0.045$), compared to those living in the rest of Sheffield. A similar study researched by Schofield et al. (1989), compared diets of pregnant women living in Edinburgh and London based on social class. The study identified those in lower social classes (5 + 6) constantly had the lowest mean intakes of micronutrients. The study suggested that this was due to possible under-reporting and incomplete records. However there was no significant difference between total energy and total fat intakes between social classes.

1.12.4 Micronutrient and macronutrient intake and marital status

A correlation between marital status and nutrient intake during pregnancy has limited research. However a hypothesis could be single mothers have a lower nutrient intake than those who are married. This hypothesis is based on the social class and diet quality theory. In the UK there is a current rise in single parent families (The Independent, 2007). Single parent families tend to have a lower income than those families with 2 people eligible to work (The Independent, 2007); therefore single parent families will have less money to spend on food.

1.12.5 Micronutrient and macronutrient intake and trimester

Few studies have explored nutrient intake in comparison with different trimesters (Bang & Lees, 2009; Keenan & Stapleton 2010). The results from the studies are unclear and

do not state an apparent hypothesis. Bang and Lees (2009) found that women in the final trimester had greater nutrient intakes. Keenan &Stapleton (2010) state this is due higher energy needs and greater hunger levels.

1.12.6 Micronutrient and macronutrient intake and number of previous pregnancies

Limited research has been conducted on number of previous pregnancies and nutrient intake during gestation. One study by Philipps and Johnson (1977) found a positive correlation between number of previous pregnancies and birth weight, mean birth weight was lower than who had had previous pregnancies. A study conducted by Olausson et al (2008) in Oxford, found that after giving birth average maternal Bone Mineral Density (BMD) depleted by 1-4%. This finding suggests that those who have previously given birth will have a greater BMD loss and BMD loss will continue if pregnancy occurs. This would lead to a hypothesis that those women who have previously given birth will have greater nutrient intakes especially calcium to accommodate for previous BMD loss. This topic needs further investigation as no clear conclusions have been achieved.

1.13 Why is the topic relevant to Public Health Nutrition (PHN?)

This study is relevant to PHN because it is important that all pregnant women are fully aware of the importance of micronutrient and macronutrient intake can have on themselves and the foetus throughout gestation. Recent media coverage revealed many pregnant women still believe they should be “eating for two”, when in fact this may cause harm to the mother and foetus (The Daily Mail, 2010; the Times, 2010). This saying demonstrates that many pregnant women are not fully aware of dietary advice for a healthy pregnancy. A lot of current nutrition information given to pregnant women

focuses mainly on calcium, iron and folate (Sinikovic et al., 2007). More awareness needs to be raised regarding the importance of other vital nutrients required during pregnancy.

Furthermore many websites targeted at pregnant women are encouraging their audience to take vitamin, mineral and n-3 fatty acids supplements throughout pregnancy. However a lot of this information is not based on government recommendations and can be sending out inaccurate messages, which may lead to confusion and health problems such as pregnant women consuming excess contaminants from mercury and dioxin if n-3 fatty acids intake is increased without being monitored (Jenson, 2006).

Raising awareness and intake of micronutrients and macronutrients are extremely important as it could help prevent LBW and premature births as well as lowering risks of nutrient deficient disorders in babies, infants and in the mother. Which may have negative effects later on in life coronary heart disease, CVD and diabetes.

1.14 What are the gaps in research?

A lot of research has been carried out regarding the subject and even though many studies offer firm conclusions associated with micronutrient and macronutrient deficiency and birth outcome, much of the research in incomplete, inconsistent and not truly representative of the population. Furthermore few studies have investigated multiple micronutrient and macronutrient intakes and their affects during pregnancy. There is also limited research regarding how much pregnant women understand about micronutrient and macronutrient intakes and their importance for pregnancy.

1.15 Aims and objectives

1.15.1 Aim

To investigate if intakes of key micronutrients and macronutrients during pregnancy reflect the understanding of specific micronutrients and macronutrients.

1.15.2 Objectives

A. To assess mean intakes of micronutrients and macronutrients

B. To investigate if knowledge of micronutrients and macronutrients affects total intake

C. To investigate if age, marital status, occupation, trimester, number of previous pregnancies and smoking affects total micronutrient and macronutrient intake

D. To investigate if age, marital status, occupation, trimester, number of previous pregnancies and smoking affect understanding of key micronutrients and macronutrients

2.0 Methodology

2.1 Study design

The study design was a prospective observational study, the participants were observed and relevant outcomes were measured. The project used a repeated measures design; therefore all subjects received identical questionnaires and food diaries. The research project consisted of quantitative and qualitative data. However qualitative data was converted to quantitative data by number coding qualitative answers (appendix 7). The project aimed to investigate if there were associations between nutritional knowledge of key micronutrients and macronutrients and dietary intakes of selected micronutrients and macronutrients during pregnancy. This was carried out using a questionnaire and a 3 day food diary.

2.2 Subjects and Recruitment

Study participants were pregnant women aged 19-50 years attending 3 different antenatal classes across Merseyside, UK.

Recruitment started in October 2010 (figure 2.1). 47 Participants were recruited at the antenatal clinic via a letter describing the study and informing potential participants what was expected from them (appendix 1). Those who expressed interest in the study were given a participant information sheet (appendix 1a) and consent form (appendix 2). The same evening the consent forms were collected and the 3 day food diaries were handed out with corresponding I.D. numbers from the consent form (appendix 3). The following week the researcher returned and collected the food diaries and handed out questionnaires, with corresponding I.D. numbers, these were collected the following week (appendix 4).

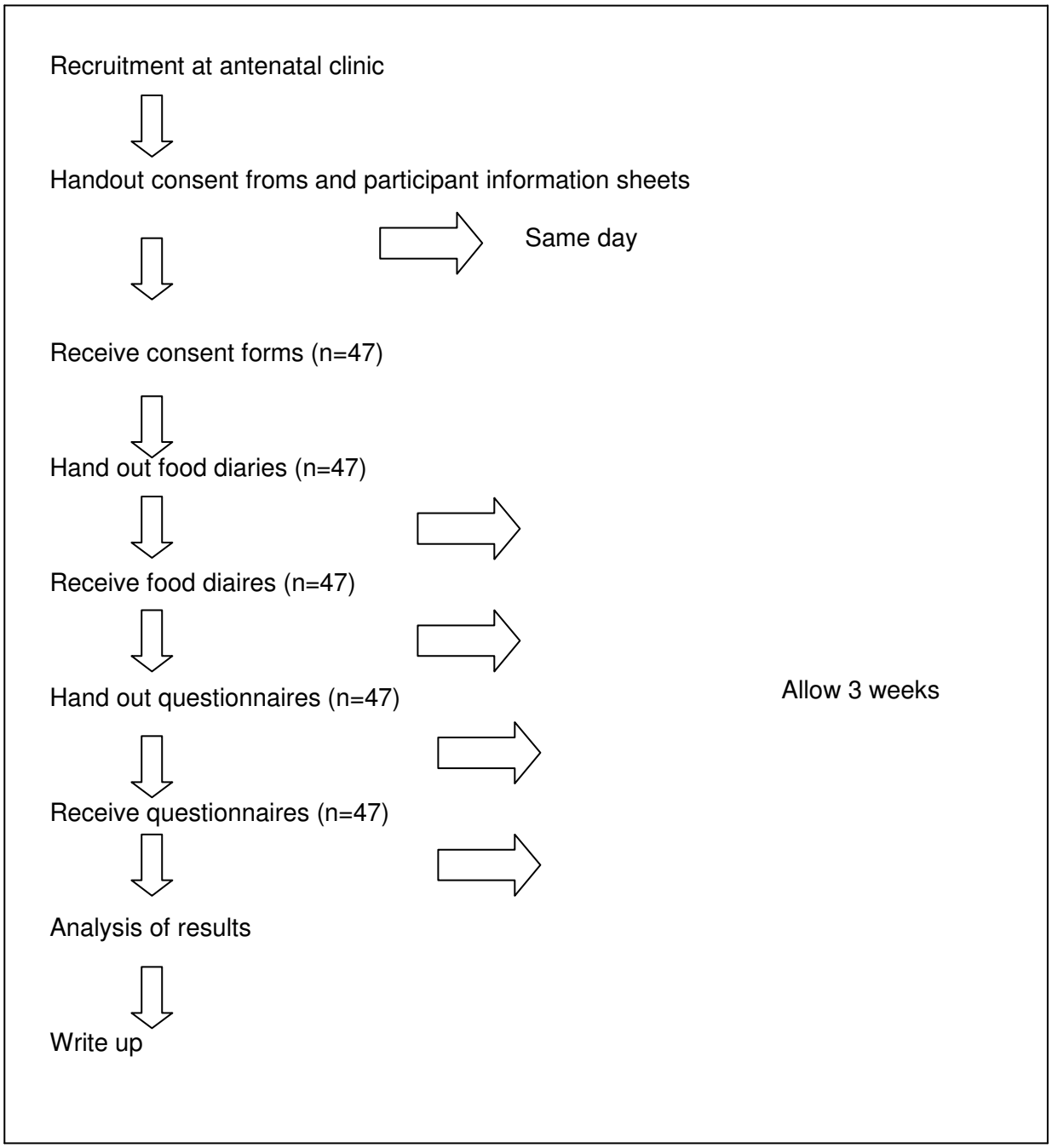

Figure 2.1 Recruitment and procedure of study

2.2.1 Inclusion criteria

- Pregnant women
- Aged 19 – 50 years
- Living in Liverpool

The inclusion criteria were verified by the researcher as letters were not be handed out to non pregnant women. Further verification was accommodated through self reporting in the questionnaire (appendix 4). For example the questionnaire asked date of birth; if the age did not fit within the inclusion criteria then their information was not included in the study.

2.2.2 Exclusion criteria

- Non pregnant women
- Aged 18 years or younger
- Aged 50 years or older
- Not living in Liverpool
- Non English speaking

2.2.3 Ethical approval

All subjects gave their informed consent to participate in the study. The University of Chester Faculty Research Ethics Committee (FREC) approved the study protocol.

2.3 Statistical analysis

Data was anlaysed using the software package 'Statistical Package for the Social Sciences' (SPSS) version 18. Descriptive statistics were performed to categorise the study population. The descriptive statistics were used to show the mean and Standard Deviation (S.D.), frequencies and percenatges of the different variables.

Chi squared tests were carried out to identify differences between groups for non continous data, for example test score groups against marital status, occupation group, trimester, number of previous pregnancies and age groups. Level of signficance was established as 0.05.

Tests including a mean number and S.D. and 3 or more groups were analysed using one-way ANOVA, Kruskal Wallis test, with appropriate post hoc test to establish significant groups. This analysis was used for testing mean RNIs against age groups, occuapation groups, marital status and score group. Level of significance was established at 0.05.

Box plots were produced when the one-way ANOVA, Kruskal Wallis tests, showed significance (p=0.05). The box plots were used to show the significant difference amongst the group.

T tests were used to test significant difference between variable with less than 3 groups such as trimester and number of previous pregnancies. Level of signifance was established at 0.05.

Pearson correlation coeffcient was used to test correlations between variables with continous data such as age and number of weeks pregnant. Graphs and line of regression (r) were used to further show correlations.

2.3.1 Sample size estimation

The sample size calculation was conducted using GPower 3 (Buchner, A., Erdfelder, E., & Faul, F,1997). To carry out an appropriate test, an F test, ANOVA: fixed effects, omnibus, one-way was selected. The number of groups included were 3 as the majority of statistical analysis included 3 groups. The effect size = 0.5, the significance = 5% and the power = 0.8. The results indicated that a sample size of 42 was required to conduct the study.

2.3.2 Response rate and drop out rate

A sample size of 42 subjects were calculated to gain possibly significant results. In order to account for a 10% drop out rate the study aimed to recruit 46 participants. Overall the study recruited 47 particiapants. All 47 participants completed the study.

2.4 Dietary analysis

Mean nutrient intakes were calculated using Microdiet (downlee systems ltd, 2005). Microdiet allowed comparisons between RNIs and Dietary Reference Values (DRVs). Micro diet compared the DRVs and RNIs to the RNIs and DRVs set by COMA, 1991, for pregnant women (table 1.1). Individual 3 day food diaries from each participant were entered into Microdiet. Each pariticpants 3 day food diary had their own I.D. number. The following nutrients were calculated, mean intake of calcium, iodine, iron, zinc, folate, vitamin A, Vitamin C, vitamin D and n-3 fatty acids and were entered into the SPSS spreadsheet into different variables for each nutrient.

2.5 Data management

The data from the questionnaire and food diary were entered into a spreadsheet using SPSS. Subject characteristics were entered as the variables, I.D. number, date of birth, weight, height, martial status, occupation, number of weeks into pregnancy, number of previous pregnancies, smokers, correctly identified the RNI for calcium, iodine, iron, zinc, folate, vitamin A and vitamin C, correctly identified food sources of calcium, iodine, iron, zinc, folate, vitamin A and vitamin C, correctly identified RDA for n-3 fatty acids and food source of n-3 fatty acids, correctly identified deficiencies of calcium, iodine, iron, zinc, folate, vitamin A, Vitamin C and n3 fatty acid and total score.

All answers were number coded (appendix 7), to allow quantitave data to be analysed. For example correctly identifying RNIs, RDAs, food sources and deficiencies were labelled 1 and incorrect answers were labelled 2-5.

Variables such as date of birth, occupation, number of previous pregnancies, weeks pregnant and total score were recoded into different variable groups to allow a more even distribution of results and to possibly eliminate bias, for example age was categorised into age group, in which 22- 26 year olds were labelled '1', 27-30 year olds were lablled '2' and 31-37 year olds were labelled '3'. The same applied to weeks pregnant which was categorised into trimester and number of previous pregnancies was categorised into 'none' and 'more than one previous pregnancy' (appendix 7). The different ranges for the groups were categorised by frequencies to allow more even group numbers.

3.0 Results

3.1 Population characteristics

The characteristics of the study population are displayed in table 3.1 and 3.2. The mean (± S.D.) age of the study population was 29 ± 3.3. Age groups were categorised into 3 groups to ensure a more even distribution of results, the most common age group was 27-30 years, this group contained 38.3% (n=18) of participants. 36.2% (n=17) fell into the 31-37 years category and 25.5% (n=12) fell into the youngest age group [22-26 years] (figure 3.0).

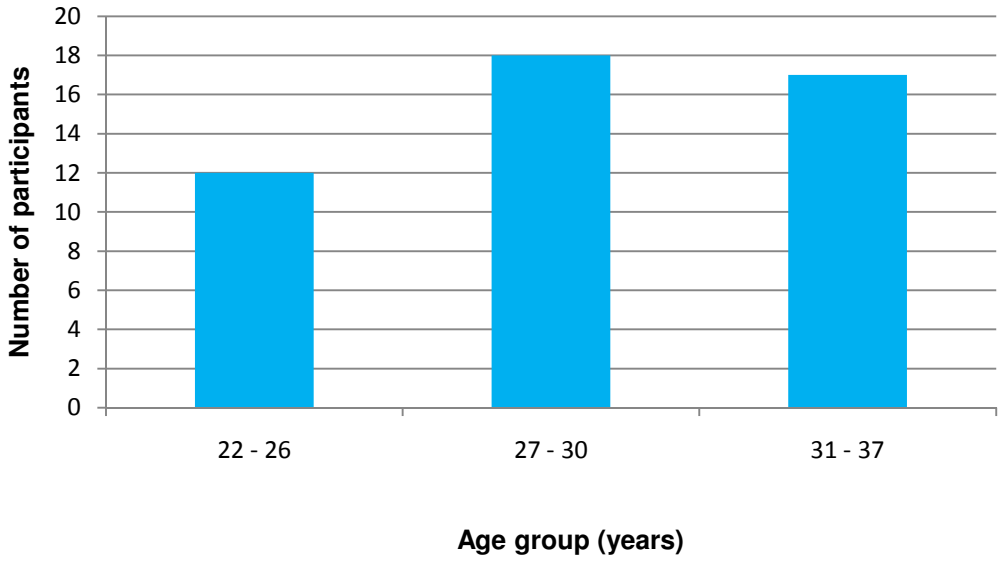

Figure 3.0 Number of participants (n=47) in different age groups

The average weight (kgs) of the study population was 73.6 ± 8.4 kg, with a range of 35 kgs. The mean height (cm) of the study population was 165.19 ± 6.5 cm, with a range of 28cm (table 3.1).

Table 3.1 Characteristics of study population (mean ± S.D.)

Variable	Mean± S.D.	Range
Age (years)	29 ±3.3	15
Weight (kgs)	73.6 ± 18.4	35
Height (cm)	165.19 ± 6.5	28

The majority, 51% (n=24) of the study population were married, 10 participants (21.3%) were single and 13 reported having a partner (27.7%). 51% (n=24) had a skilled occupation, whereas 17% (n=8) reported having a semi skilled occupation and 31.9% (n=15) subjects fell into the unskilled category. The minority of subjects were smokers (n=4), however information of how many cigarettes smoked per day was not included. The study population were either in their first trimester (48.9%) or their second trimester (51%). The majority, 66% (n=31), of subjects did not have any previous pregnancies and 34% (n=16) had had one or more previous pregnancies (table 3.2).

Table 3.2 Characteristics of study population (frequency and percentage)

Variable	Frequency (n=47)	Percentage (%)
Age group (years)		
1. 22-26	12	25.5
2. 27-30	18	38.3
3. 31-37	17	36.2
Marital status		
1. Single	10	21.3
2. Partner	13	27.7
3. married	24	51.0
Occupation group		
1. Skilled	24	51.1
2. Semi skilled	8	17.0
3. Unskilled	15	31.9
Smokers		
1. Yes	4	8.5
2. No	43	91.5
Trimester		
1. First trimester	23	48.9
2. Second trimester	24	51.1
Number of previous pregnancies		
1. No previous pregnancies	31	66.0
2. One or more previous pregnancies	16	34.0

3.2 Nutritional knowledge of the importance of micronutrient and macronutrient intake during pregnancy

Knowledge of micronutrient and macronutrient intake during pregnancy was assessed using a questionnaire (appendix 4). Knowledge of the importance of micronutrient and macronutrient intake was defined by score groups. Score groups, included, low (0-7), medium (8-10) and high (11-24) knowledge. Each question carried one mark; a top mark of 24 could be obtained.

Table 3.3 shows the questions regarding knowledge of RNIs of mineral, vitamins and n-3 fatty acids. RNIs used are those set by COMA (1991) adjusted for pregnant women.

Folate was the most correctly identified RNI, 55.3% (n=26) of participants correctly identified the RNI for folate, followed by 36.2% (n=17) of participants correctly identifying the RNI for calcium. The least correctly identified RNI was for iodine with only 10.6% (n=5) of participants correctly identifying the RNI, followed by zinc, 12.8% (n=6).

The majority of participants 97.9% (n=46) correctly identified the major sources of calcium and vitamin C. Nearly all participants, 93.6% (n= 44), correctly identified the major source of iron. Major sources of folate, vitamin A and n-3 fatty acids were correctly identified by over 50% of participants. Major sources of iodine and zinc were the least correctly identified with 19.1% (n=9) and 12.8% (n=6) of participants correctly identifying the major food sources, respectively.

63.8% (n=30) of participants correctly identified a possible birth defect caused by folate deficiency during pregnancy. Over 50% of participants failed to identify possible birth defects caused by mineral, vitamin and n-3 fatty acid deficiency during pregnancy for all the remaining micronutrients and macronutrients. Vitamin A was the least correctly identified question with only 6.4% (n=3) of participants correctly identifying a possible birth defect caused by its deficiency during pregnancy.

Table 3.3 Frequency and percentage of correct and incorrect answers

Question		Correct		Incorrect	
		n=47	%	n=47	%
Do you know the recommended intake for the following minerals and vitamins during pregnancy:	Calcium	17	36.2	30	63.8
	Iodine	5	10.6	42	89.4
	Iron	14	29.8	33	70.2
	Zinc	6	12.8	41	87.2
	Folate	26	55.3	21	44.7
	Vitamin A	8	17	39	83
	Vitamin C	13	27.7	34	72.3
Do you know the major sources of the following minerals and vitamins:	Calcium	46	97.9	1	2.9
	Iodine	9	19.1	38	80.9
	Iron	44	93.6	3	6.4
	Zinc	6	12.8	41	87.2
	Folate	27	57.4	20	42.6
	Vitamin A	29	61.7	18	38.3
	Vitamin C	46	97.9	1	2.9
Do you know the recommended intake for omega 3 fatty acids during pregnancy?		9	19.1	38	80.9
Do you know the major sources of omega 3 fatty acids?		33	70.2	14	29.8
Do you know any possible birth defect that may be caused by the following mineral and vitamin deficiencies during pregnancy:	Calcium	23	48.9	24	51.1
	Iodine	5	10.6	42	89.4
	Iron	26	55.3	21	44.7
	Zinc	7	14.9	40	85.1
	Folate	30	63.8	17	36.2
	Vitamin A	3	6.4	44	93.6
	Vitamin C	13	27.7	34	72.3
Do you know any possible birth defect that may be caused by omega 3 fatty acids deficiency during pregnancy?		14	29.8	3	70.2

3.2.1 Nutritional knowledge and age group

Nutritional knowledge was assessed by overall score from the questionnaire. As mentioned previously the participants were categorised into 3 separate score groups depending on how many questions they correctly identified (appendix 7). Therefore nutritional knowledge was defined by score group.

No significant difference was found between age category and score group (P=0.109). The youngest age category (22-26 years) had the highest number of participants in the low scoring group (n=6) and the lowest amount of participants in the high scoring group (n=1). 27-30 years had the lowest number of participants in the low scoring group (n=3) and the highest number of participants in the high scoring group [n=10] (table 3.4).

Table.3.4 Age category and score group

	Age category (years)		
Score group	22-26 (n=12)	27-30 (n=18)	31-37 (n=17)
Low (0-7)	6	3	5
Medium (8-10)	5	5	6
High (11-24)	1	10	6

3.2.2 Nutritional knowledge and marital status

No significant differences were established between marital status and score group (p=0.258). The participants in the married category had the highest amount of participants in the high scoring group (n=11), those in the single category had the lowest number of participants in the high scoring group (n=2). Participants with a partner had the lowest amount of participants in the low scoring group [n=3] (table 3.5).

Table 3.5 Marital status and score group

	Marital status		
Score group	Single (n=10)	Partner (n= 13)	Married (n= 24)
Low (0-7)	4	3	7
Medium (8-10)	4	6	6
High (11-24)	2	4	11

3.2.3 Nutritional knowledge and occupation group

Pearson's chi squared test showed a significant difference between occupation group and score group (p=0.009), suggesting those in the skilled category have a better knowledge of adequate micronutrient and macronutrient intake during pregnancy compared to those in the semi skilled and unskilled category (table 3.6).

Table 3.6 Occupation group and score group

	Occupation group		
Score group	Skilled (n=24)	Semi skilled (n=8)	Unskilled (n= 15)
Low (0-7)	3	5	7
Medium (8-10)	7	2	6
High (11-24)	14*	1	2

*Correlation is significant at the 0.05 level

3.2.4 Nutritional knowledge and trimester

Pearson's chi squared test showed no significant difference between trimester and score group (p=0.142).

Table 3.7 shows the scores for each group. Those women in their second trimester had the highest number of participants in the high scoring group (n=10) but also had the highest number of participants in the low scoring group (n=9) compared to those in their first trimester.

Table 3.7 Trimester and score group

	Trimester	
Score group	First trimester (n=23)	Second trimester (n=24)
Low (0-7)	5	9
Medium (8-10)	11	5
High (11-24)	7	10

3.2.5 Nutritional knowledge and number of previous pregnancies

No significant difference were established between nutritional knowledge (score group) and number of previous pregnancies (p=0.453). Participants who indicated had not had a previous pregnancy had the highest number of participants in the low scoring group (n=8) and the highest number of participants in the high scoring group (n=12) compared to those who reported having one or more previous pregnancies (table 3.8).

Table 3.8 Number of previous pregnancies and score group

	Number of previous pregnancies	
Score group	No previous pregnancies (n=31)	One or more previous pregnancies (n=16)
Low (0-7)	8	6
Medium (8-10)	11	5
High (11-24)	12	5

3.3 Dietary micronutrient and macronutrient intake

All intakes were based on dietary consumption only, mineral and vitamin supplements were not included.

3.3.1 Calcium intake

Overall 63.8% (n=30) consumed the RNI, for pregnant women, (700mg/day) for calcium and 36.2% (n=17) failed to meet RNI for calcium, as shown in the figure 3.1. Mean consumption of calcium for this study was 788.6 ± 210.5 mg/day.

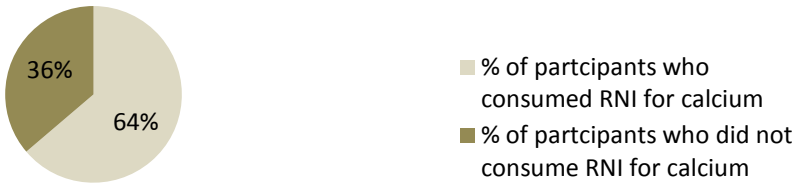

Figure 3.1 % of participants who consumed and did not consume the RNI for calcium (700mg/day).

3.3.2 Iodine intake

80.9% (n=38) of participants failed to consume the RNI, for pregnant women, for iodine (140 µg/day) and 19.1% (n=9) met the RNI, as shown in figure 3.2. Mean consumption of iodine for this study was 103.5 ± 48.1 µg/day.

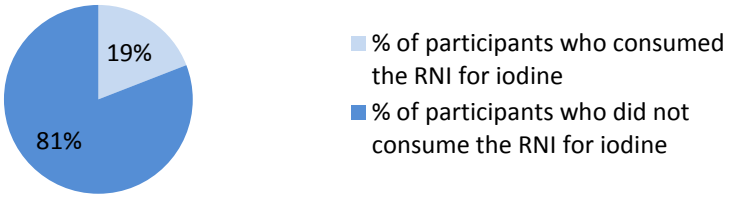

Figure 3.2 % of participants who consumed and did not consume the RNI for iodine (140 µg/day)

3.3.3 Iron intake

14.9% (n=7) of participants consumed the RNI, for pregnant women, for iron (14.8 mg/day). The majority of participants (85.1%, n=40) failed to meet the RNI for iron, as shown in figure 3.3. Mean consumption of iron for this study was 11.65 ± 3.1 mg/day.

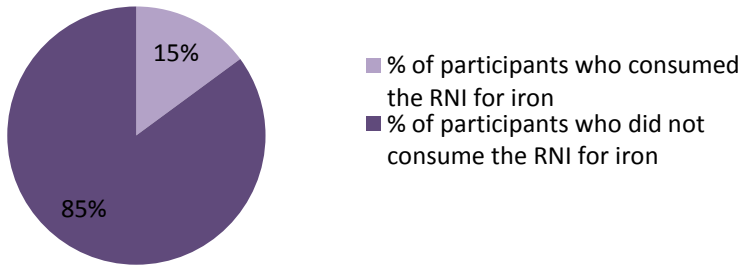

Figure 3.3 % of participants who consumed and did not consume the RNI for iron (14.8mg/day)

3.3.4 Zinc intake

The majority of participants (80.9%, n=38) consumed the RNI, for pregnant women, for zinc and less than 20% (n=9) did not consume the RNI for zinc (7.0 mg/day), shown in figure 3.4. Mean consumption of zinc for this study was 9.2 ± 3.1 mg/day.

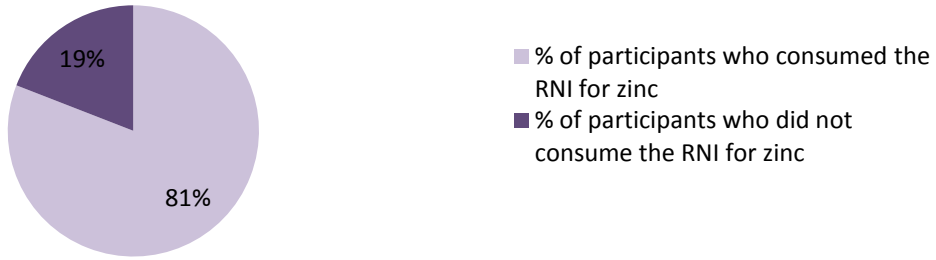

Figure 3.4 % of participants who consumed and did not consume the RNI for zinc (7.0mg/day)

3.3.5 Folate intake

The majority of participants (72.3%, n=34) failed to consume the RNI, for pregnant women, for folate. 27.7% (n=13) achieved the RNI for folate (300 µg/day), shown in figure 3.5. Mean consumption of folate for this study was 246.0 ± 132.6 µg/day.

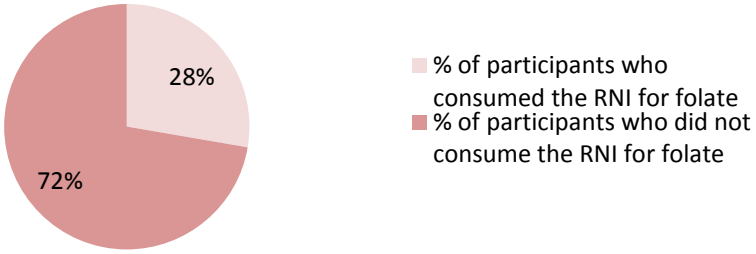

Figure 3.5 % of participants who consumed and did not consume the RNI for folate (300 µg/day).

3.3.6 Vitamin A intake

95.7% (n=45) of participants did not consume the RNI, for pregnant women, for vitamin A. The minority (4.3%, n=2) consumed the RNI for vitamin A (700 µg/d), shown in figure 3.6. Mean consumption of vitamin A for this study was 290.9 ± 163.2 µg/day.

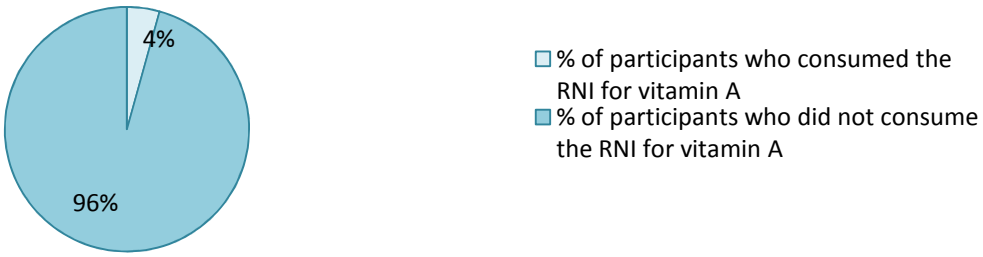

Figure 3.6 % of participants who consumed and did not consume the RNI for Vitamin A (700 µg/day).

3.3.7 Vitamin C intake

More than half of participants (59.6%, n=28) consumed the RNI, for pregnant women, for vitamin C. 40.4% (n=19) did not consume the RNI for vitamin C (50mg/day), shown in figure 3.7. Mean consumption of vitamin C for this study was 62.5 ± 35.3 mg/day.

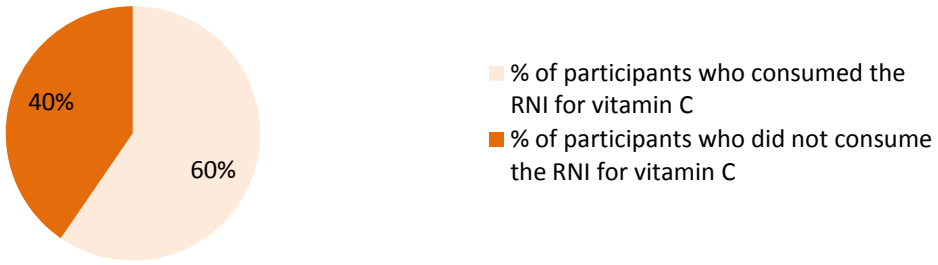

Figure 3.7 % of participants who consumed and did not consume the RNI for vitamin C (50mg/day).

3.3.8 Vitamin D intake

100% did not consume the RNI, for pregnant women, (10µg/day) for vitamin D. shown in figure 3.8. Mean consumption of vitamin D for this study was 2.5 ± 1.9 µg/day.

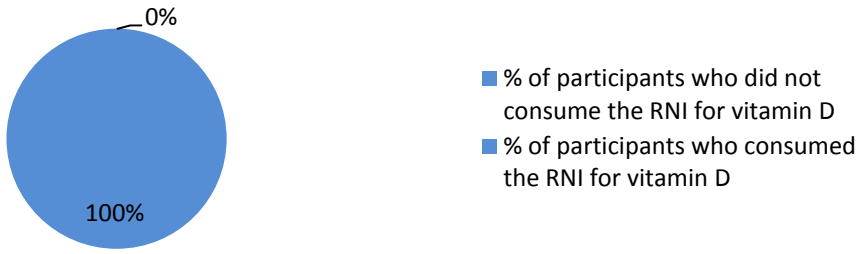

Figure 3.8 % of participants who consumed and did not consume the RNI for vitamin D (10µg/day).

3.3.9 Omega 3 fatty acids intake

The RDA for n-3 fatty acids, for women aged 19-50 years, was met by 42.6% (n=20) of participants. 57.4% (n=27) did not meet the RDA for n-3 fatty acids (300mg/day), shown in figure 3.9. Mean consumption of n-3 fatty acids for this study was 243.6 ± 209.4 mg/day.

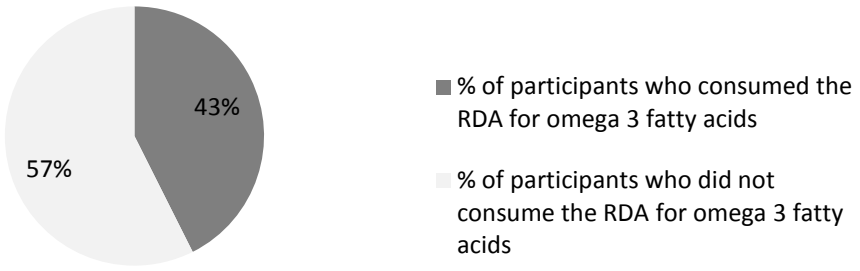

Figure 3.9 % of participants who consumed and did not consume the RDA for omega 3 fatty acids (300mg/day).

3.4 Mean dietary micronutrient and macronutrient intake and age group

No significant differences were established between mean micronutrient and macronutrient intakes and age group.

The 31-37 years group (n=17) had the highest consumption for mean iron and vitamin C intake, 12.3 mg/day ± 2.2 and 71.5 mg/day ± 39.2 respectively (table 3.9). Compared to the youngest age group 22-26 years (n=12) who had the lowest mean consumption of iron and vitamin C, 11.3 mg/day ± 3.0 and 45.2 mg/day ± 28.4 respectively (table 3.9).

Table 3.9 Age group and mean dietary micronutrient and macronutrient intake

	Age group (mean ± S.D.)		
Mean micronutrient and macronutrient intake	22-26 (n=12)	27-30 (n=18)	31-37 (n=17)
Calcium (mg)	803.0 ± 197.5	804.7 ± 231.9	761.4 ± 205.1
Iodine (µg)	98.2 ± 44.6	102.7 ± 42.9	108.0 ± 57.3
Iron (mg)	11.3 ± 3.8	11.3 ± 3.2	12.3 ± 2.2
Zinc (mg)	8.2 ± 1.7	9.1 ± 2.4	9.9 ± 4.4
Folate (µg)	221.8 ± 113.4	222.5 ± 89.3	289.1 ± 116.6
Vitamin A (µg)	369.0 ± 206.3	321.4 ± 121.0	273.5 ± 158.6
Vitamin C (mg)	45.2 ± 28.4	65.6 ± 33.7	71.5 ± 39.2
Vitamin D (µg)	2.8 ± 1.7	3.0 ± 2.2	3.6 ± 2.5
Omega 3 fatty acids (mg)	345.0 ± 26.7	386.7 ± 24.4	242.9 ± 14.4

3.4.1 Association between mean dietary micronutrient and macronutrient intake and age

There was a significant positive correlation between age and mean folate (p=0.018) and vitamin C (p=0.002) intakes (table3.9.1). Both correlations were positive, shown figures 3.10 and 3.11.

Table 3.9.1 Pearson correlation coefficient between mean folate and vitamin C intake and age

Mean micronutrient and macronutrient intake		**Age (years)**
Folate (µd/day)	Pearson correlation Sig. (2 tailed) n	0.344* 0.018 47
Vitamin C (mg/day)	Pearson correlation Sig. (2 tailed) n	0.334* 0.0022 47

* Correlation is significant at the 0.05 level (2 tailed)

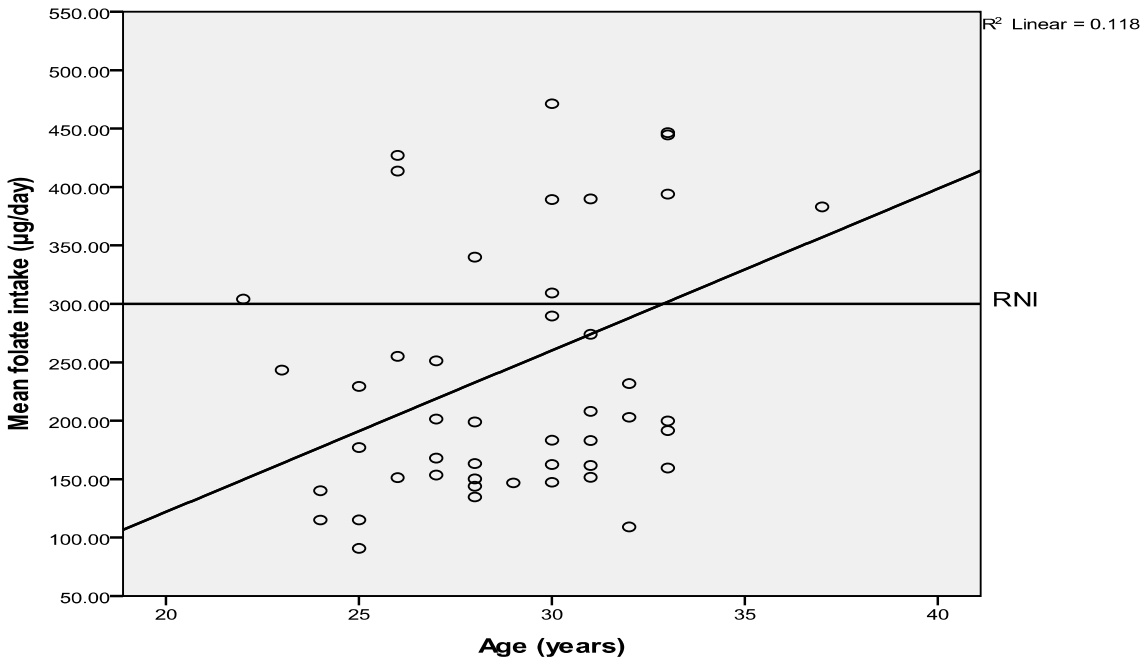

Figure 3.10 A graph to show the correlation between mean folate intake and age (R^2 = 0.118, r = 0.34).

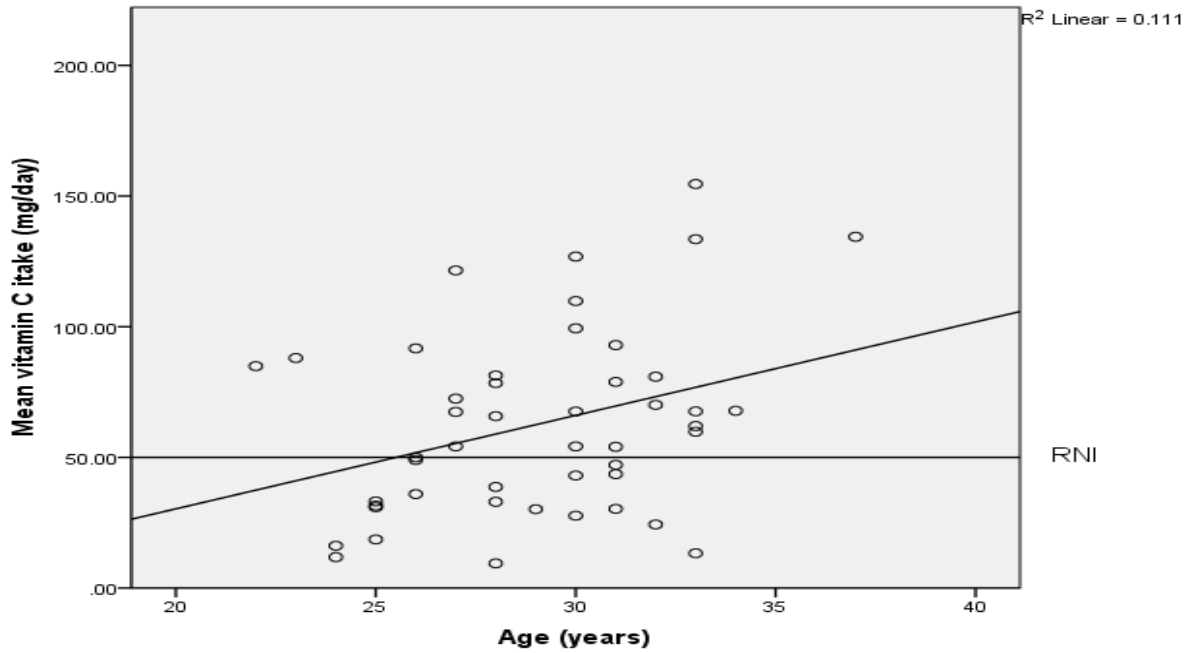

Figure 3.11 A graph to show the correlation between mean vitamin C intake and age (R^2 = 0.111, r = 0.33).

3.5 Mean dietary micronutrient and macronutrient intake analysis and marital status

No significant differences were found between marital status and mean micronutrient and macronutrient intakes, this was further confirmed by the post hoc analysis.

Those who classified themselves as married, tended to have the lowest mean intakes except for mean folate and mean vitamin C intakes, shown in table 3.10.

Table 3.10 Marital status and mean micronutrient and macronutrient intake

	Marital status (mean ± S.D.)		
Mean micronutrient and macronutrient intake	Single (n=10)	Partner (n=13)	Married (n=24)
Calcium (mg)	781.2 ± 180.9	847.3 ± 232.5	759.8 ± 211.6
Iodine (µg)	99.5 ± 38.9	104.9 ± 44.3	104.4 ± 54.8
Iron (mg)	12.0 ± 3.8	11.8 ± 3.7	11.4 ± 2.3
Zinc (mg)	9.8 ± 2.2	9.7 ± 4.9	8.7 ± 2.1
Folate (µg)	187.8 ± 74.8	261.5 ± 121.7	262.6 ± 152.8
Vitamin A (µg)	586.5 ± 201.4	291.9 ± 135.1	300.3 ± 145.4
Vitamin C (mg)	53.9 ± 32.2	59.8 ± 39.1	67.6 ± 35.1
Vitamin D (µg)	2.4 ± 1.2	1.9 ± 1.2	1.1 ± 0.3
Omega 3 fatty acids (mg)	306.2 ± 161.3	368.5 ± 262.1	307.1 ± 295.0

3.6 Mean dietary micronutrient and macronutrient intake and occupation group

Table 3.11 shows the mean ± S.D. of mean micronutrient and macronutrient intakes for the different occupation groups. Significant differences were found between mean micronutrient and macronutrient intakes and occupation groups. A significant difference was found between mean calcium intake and occupation group (p=0.004). The semi skilled group (n=8) had a significantly higher mean intake of calcium, 936.2mg/day ± 56.4 (table 3.11) than the other groups. The significantly lowest mean intake of calcium was 697.0mg/day ± 221.6 consumed by the unskilled occupation group (n=15). Mean iron, folate and vitamin C intakes were significantly different between the groups (p <0.05).

Table 3.11 Occupation group and mean micronutrient and macronutrient intake

	Occupation group (mean ± S.D.)		
Mean micronutrient and macronutrient intake	Skilled (n=24)	Semi skilled (n=8)	Unskilled (n=15)
Calcium (mg)	787.6 ± 187.7	963.2± 156.5*a	697.0 ± 221.7
Iodine (µg)	115.6 ± 54.0	87.7 ± 35.1	92.5 ± 40.8
Iron (mg)	12.6 ± 3.0*b	11.8 ± 2.2	10.1 ± 3.0
Zinc (mg)	9.7 ± 3.7	9.7 ± 2.3	8.0 ± 2.2
Folate (µg)	319.5 ± 146.8*b	203.2 ± 59.8	152.5 ± 30.0
Vitamin A (µg)	291.1 ± 145.8	303.1 ± 136.5	163.6 ± 181.6
Vitamin C (mg)	77.1 ± 34.9*b	62.0 ± 35.4	39.5 ± 23.4
Vitamin D (µg)	2.1 ± 1.0	3.6 ± 2.1	2.6 ± 2.1
Omega 3 fatty acids (mg)	384.0 ± 151.3	282.5 ± 151.9	324.1 ± 169.3

* Significantly different (p= <0.05) a = semi skilled compared to skilled

b = skilled compared to unskilled

Figure 3.12 shows how mean calcium intake is spread across the mean for each occupation group. Semi skilled and the unskilled are mainly in the upper quartile.

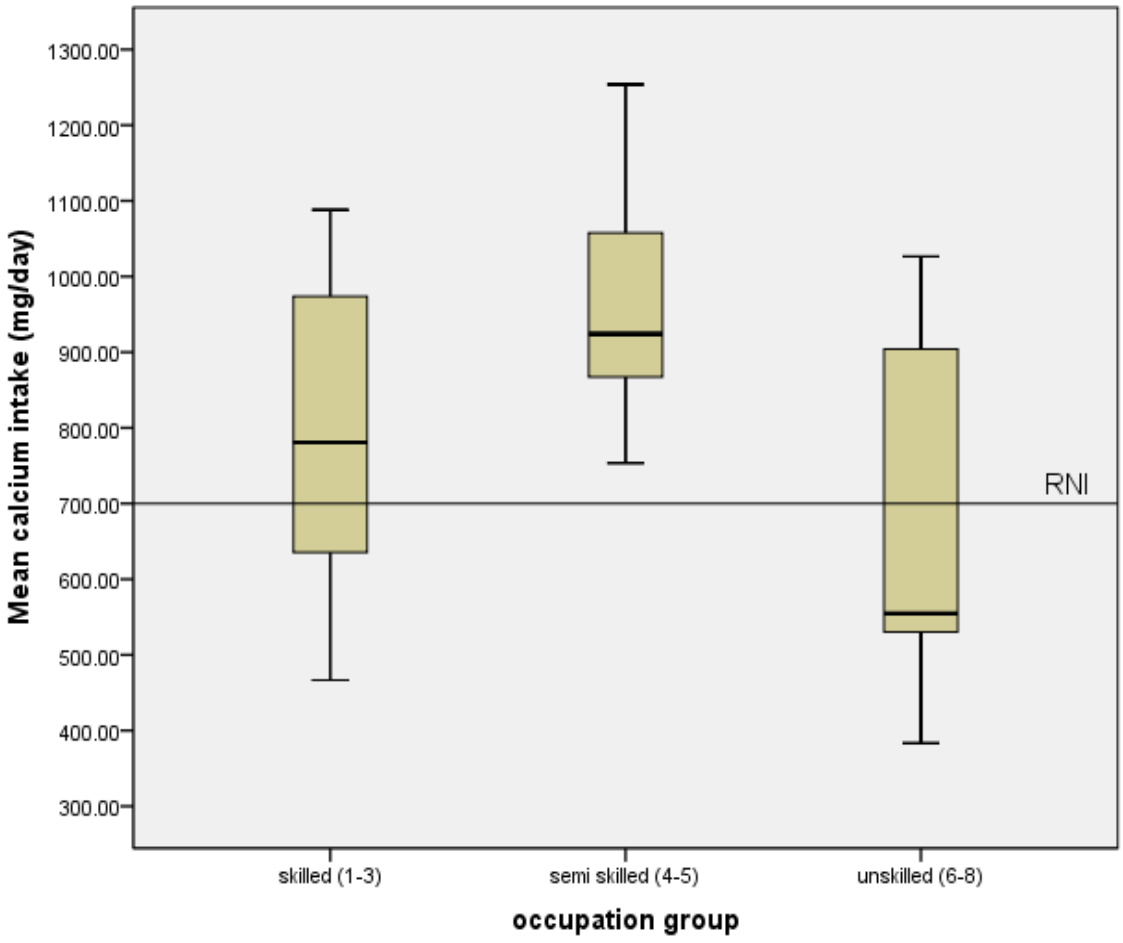

Figure 3.12 Box plot to show spread across the median of mean calcium intake (mg/day) and occupation group.

The median intakes for the skilled and semi skilled groups are above the RNI. However the median for the unskilled group are below the RNI (figure 3.12).

There was a significant difference between mean iron intake and occupation group (p=0.034). The skilled occupation group (n=24) had a significantly higher mean consumption, 13.0mg/day ± 3.0, compared to the unskilled occupation group (n=15), who had a significantly lower mean consumption, 10.1mg/day ± 3.0. Figure 3.13 shows how mean iron intake is spread across the means of the occupation groups. The skilled group are largely in the upper quartile. The semi skilled and unskilled groups are largely in the lower quartile.

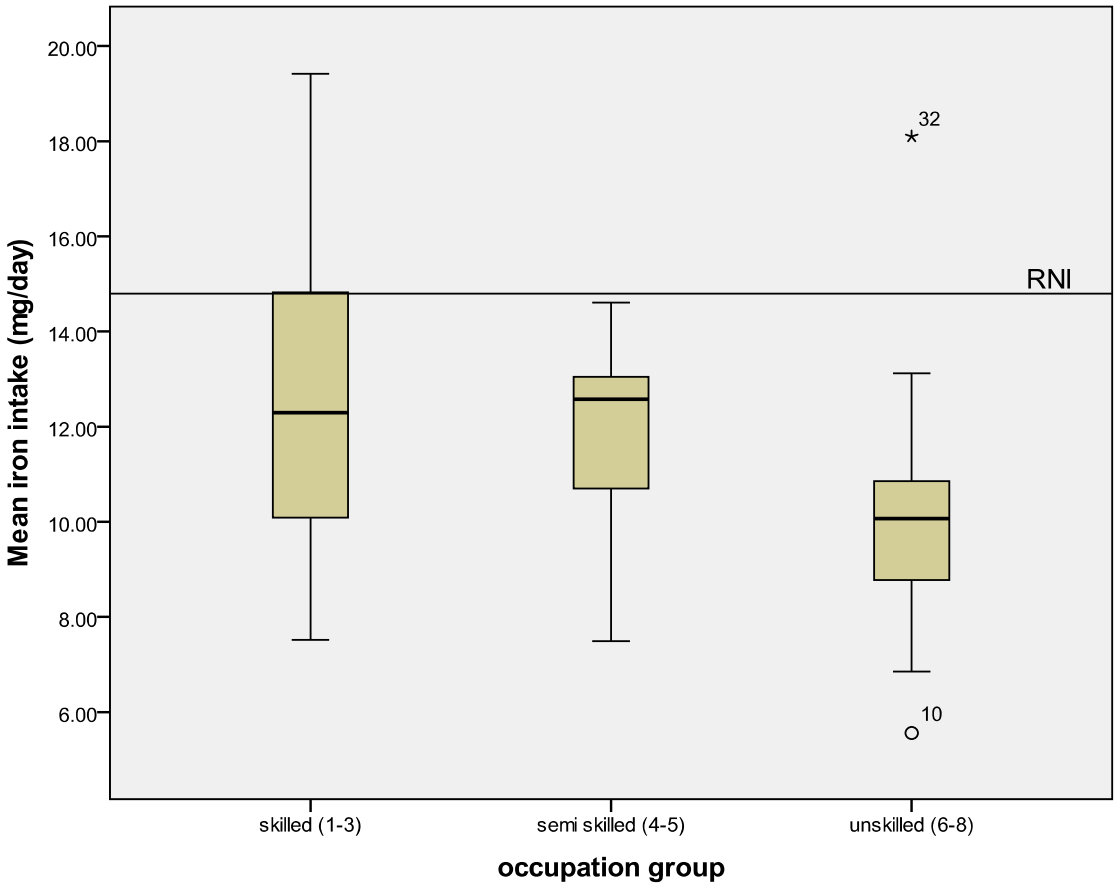

Figure 3.13 Box plot to show the spread across the median of mean iron intake (mg/day) and occupation group.

A further significant difference was found between mean folate intake and occupation group (p=0.019). The mean folate intake for the skilled group (n=24) was 319.5µg/day ± 146.8. The mean folate intake for the semi skilled group (n=8) was significantly lower than the skilled group, 203.2 µg/day ± 59.8. The mean folate intake for the unskilled occupation group (n=15) was significantly lower than the semi skilled group 152.5 µg/day ± 30.9 (table 3.11). Figure 3.14 shows mean folate intake spread across the median for occupation groups.

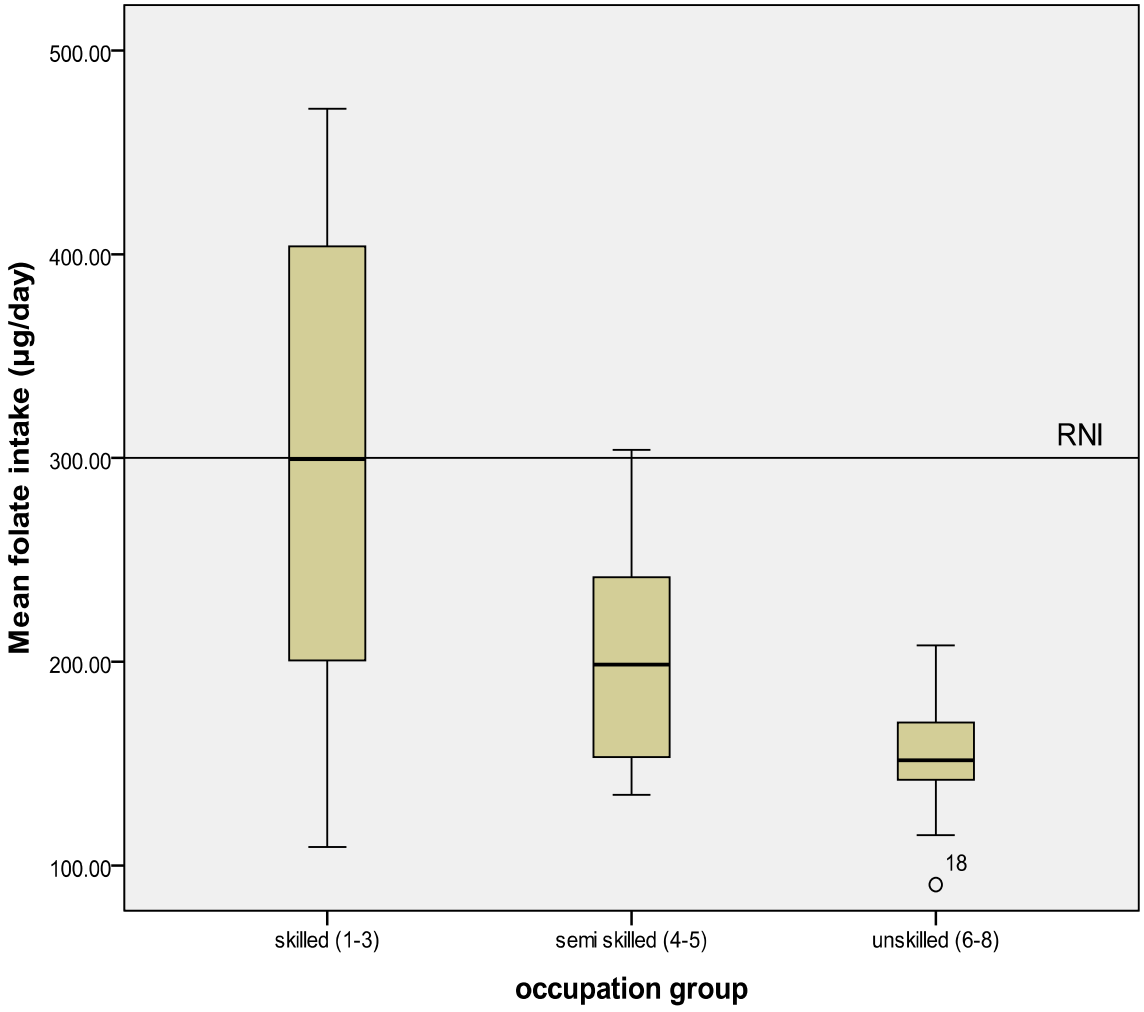

Figure 3.14 Box plot to show the spread across the median of mean folate intake (µg/day) and occupation group.

Mean vitamin C intake was significantly different among the occupation groups (p=0.004). The skilled occupation group (n=24) on average consumed 77.04mg/day ± 34.9, were as the unskilled group consumed a significantly lower average of 39.5 mg/day ± 23.4 (table 3.11). Figure 3.15 shows mean vitamin C intake spread across the range of intakes for occupation groups. The Skilled and unskilled groups are mainly in the upper quartile.

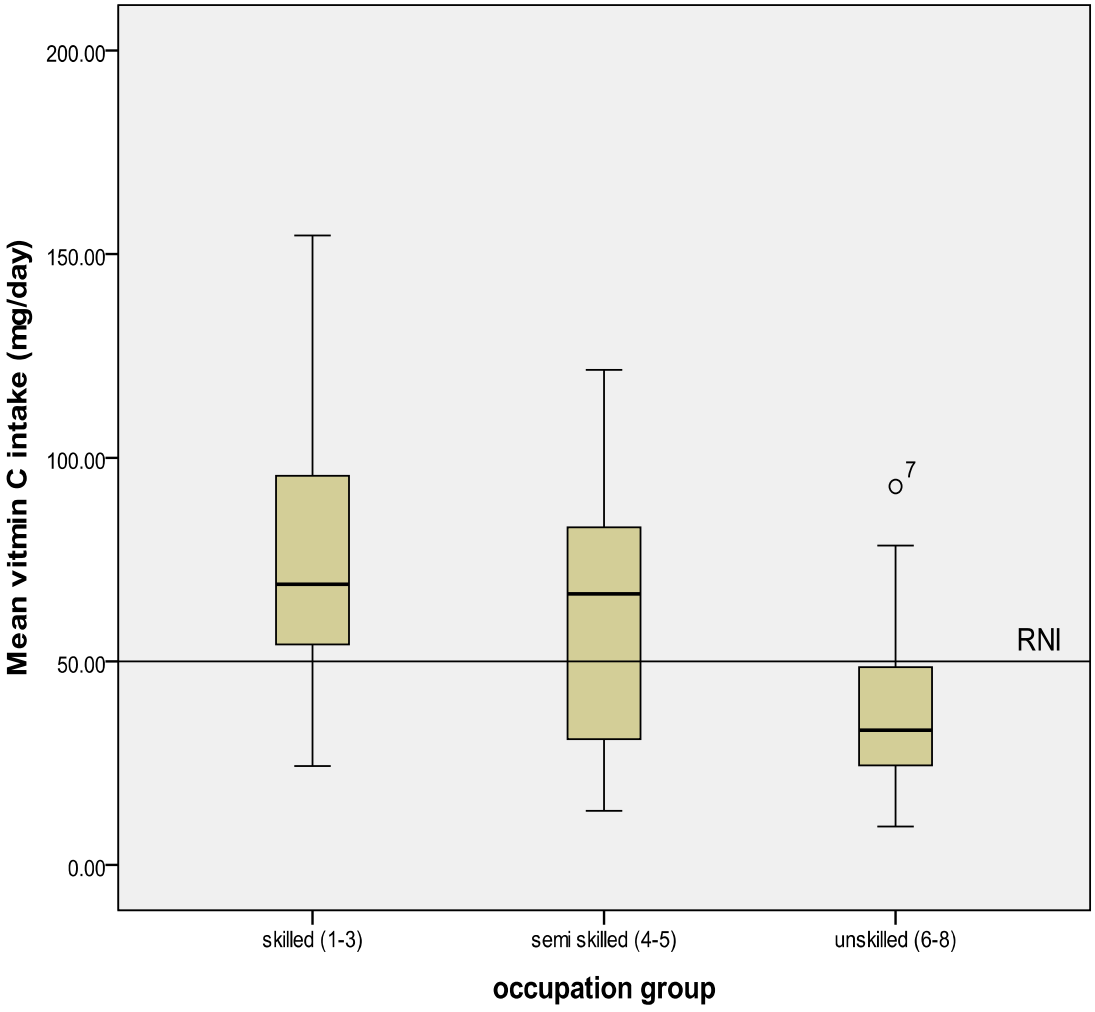

Figure 3.15 Box plot to show the spread across the median of mean vitamin C intake (mg/day) and occupation group.

3.7 Mean micronutrient and macronutrient intake and trimester

There was a significant difference between trimester and mean calcium intake (p=0.008) and mean vitamin D intake (p=0.034). Those participants in the first trimester group (n=23) consumed on average 758.6 ± 194.4 mg/day of calcium, compared to those in the second trimester (n=24) who consumed a significantly higher average, 817.3 ± 225.3 mg/day, of calcium (table 3.12). However participants in the first trimester group had a significantly higher mean intake of vitamin D (3.3 ± 1.1 µg/day) compared to the participants in the second trimester group (1.0 ± 0.3 µg/day). No other significant differences were established among the variables. Figure 3.16 shows mean calcium intake spread across the median for the different trimesters. Participants in their second trimester are largely in the lower quartile and participants in their first trimester are largely in the upper quartile.

Table 3.12 Trimester and mean dietary micronutrient and macronutrient intake

	Trimester (mean ± S.D.)	
Mean micronutrient and macronutrient intake	First trimester (n=23)	Second trimester (n=24)
Calcium (mg)	758.6 ± 194.4	817.3 ± 225.3*
Iodine (µg)	105.6 ± 48.3	101.5 ± 49.0
Iron (mg)	11.3 ± 2.6	12.0 ± 3.5
Zinc (mg)	9.4 ± 3.9	8.9 ± 2.3
Folate (µg)	226.9 ± 97.5	285.1 ± 159.1
Vitamin A (µg)	284.7 ± 124.3	209.6 ± 137.2
Vitamin C (mg)	65.6 ± 36.2	59.5 ± 35.0
Vitamin D (µg)	3.3 ± 1.1*	1.0 ± 0.3
Omega 3 fatty acids (mg)	291.7 ± 180.4	355.4 ± 136.4

* Significantly different (p = <0.05)

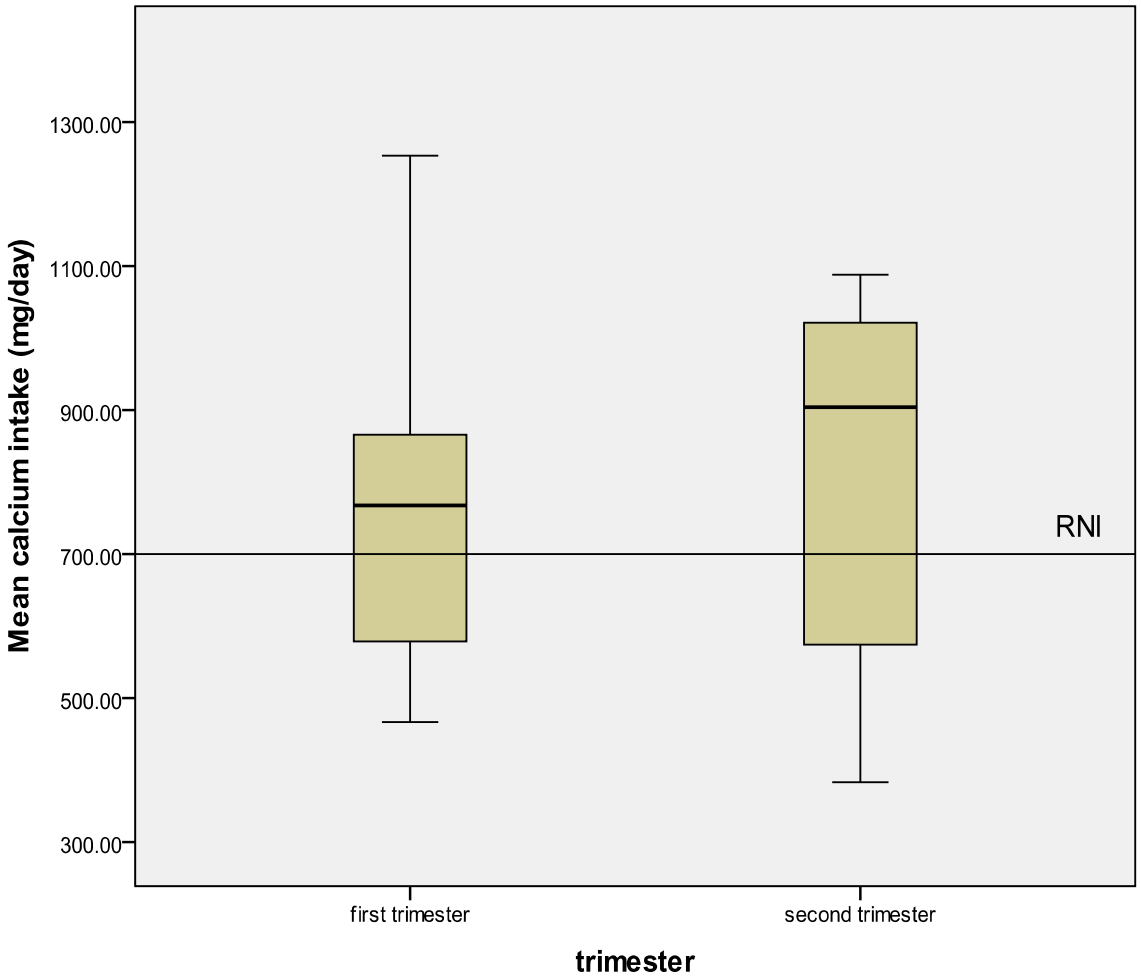

Figure 3.16 Box plot to show the spread across the median of mean calcium intake (mg/day) and trimester.

3.8 Mean dietary micronutrient and macronutrient intake and number of previous pregnancies

A significant difference was established between mean micronutrient and macronutrient intake and number of previous pregnancies. Mean vitamin C intake was significantly different amongst the groups (p=0.025). Those women who reported having one or more previous pregnancies had a significantly higher mean intake of vitamin C than those who reported had had no previous pregnancies (table3.13).

Table 3.13 Number of previous pregnancies and mean micronutrient and macronutrient intake

	Number of previous pregnancies (mean ± S.D.)	
Mean micronutrient and macronutrient intake	No previous pregnancies (n=31)	One or more previous pregnancies (n=16)
Calcium (mg)	790.3 ± 212.2	785.3 ± 214.2
Iodine (µg)	98.7 ± 40.0	112.6 ± 61.4
Iron (mg)	11.5 ± 3.1	11.9 ± 2.9
Zinc (mg)	9.1 ± 1.9	9.4 ± 4.8
Folate (µg)	251.5 ± 149.1	236.4 ± 96.4
Vitamin A (µg)	169.6 ± 74.3	266.9 ± 144.7
Vitamin C (mg)	54.5 ± 29.8	78.1 ± 40.7*
Vitamin D (µg)	1.9 ± 0.8	2.1 ± 1.1
Omega 3 fatty acids (mg)	357.7 ± 190.7	259.4 ± 95.4

*Significantly different (p = <0.05)

3.9 Nutritional knowledge and micronutrient and macronutrient intake

No significant differences were found between nutritional knowledge (categorised by score group) and mean nutrient intakes. Those categorised into the high score group had the highest mean intakes of the majority of micronutrients and macronutrients (table 3.14) and those categorised into the low score group tended to have the lowest mean intakes of micronutrients and macronutrients.

Table 3.14 Score group and mean micronutrient and macronutrient intake

	Score group (mean ± S.D.)		
Mean micronutrient and macronutrient intake	Low (n=14)	Medium (n=16)	High (n=17)
Calcium (mg)	807.8 ± 210.2	764.1 ± 240.9	795.8 ± 190.2
Iodine (µg)	81.9 ± 48.9	104.0 ± 44.1	120.6 ± 46.6
Iron (mg)	11.1 ± 2.0	11.2 ± 2.9	12.5 ± 3.8
Zinc (mg)	8.6 ± 2.3	9.0 ± 2.2	9.8 ± 4.4
Folate (µg)	204.7 ± 88.4	217.5 ± 94.6	307.9 ± 171.5
Vitamin A (µg)	345.3 ± 158.1	283.6 ± 134.5	323.2 ± 145.3
Vitamin C (mg)	57.0 ± 42.7	57.4 ± 36.2	71.9 ± 27.1
Vitamin D (µg)	3.1 ± 2.7	2.7 ± 2.0	2.8 ± 1.9
Omega 3 fatty acids (mg)	282.1 ± 119.0	313.9 ± 82.6	259.3 ± 103.8

4.0 Discussion

The purpose of this research project was to investigate if intakes of key micronutrients and macronutrients during pregnancy reflect the understanding of specific micronutrients and macronutrients. The study further hypothesised if age, marital status, occupation, trimester of pregnancy, number of previous pregnancies and smoking affects total micronutrient and macronutrient intake and affects understanding of key micronutrients and macronutrients.

4.1 Assessment of methodology

A non validated questionnaire was used to assess participants' knowledge about micronutrient and macronutrient requirements during pregnancy. The questionnaire was conducted in two sections. The first section regarded personal details and the second section focused on RNIs, RDAs, food sources and possible birth defects due to deficiencies in micronutrients and macronutrients.

Assessing dietary intake during gestation is complicated due to factors that are dependent on the period on gestation, such as nausea, cravings, aversions and appetite fluctuations (Wirfalt, 1998). A 3 day food diary (including 2 week days and 1 weekend day) was used to assess participants' mean nutrient intakes. A 3 day food diary, with requirement of estimated weights, was used as food diaries in previous studies have produced reliable and accurate results (Crozier et al, 2006 & Bingham et al, 1993). Bingham et al (1993) concluded that food diaries, with estimated weights, gave more accurate nutrient intake totals compared to Food Frequency Questionnaires (FFQ). Some food diaries in this study were very vague and some weight estimates were left blank therefore weights were estimated based on average food portions on packets. This could affect accuracy of results due to under-reporting.

An observational study was the most appropriate kind for this research because the aim was to investigate if food intakes of key micronutrients and macronutrients during pregnancy reflect the understanding of specific micronutrients and macronutrients. Therefore separate groups and treatments were not necessary and participants' nutrition knowledge and food intake of key micronutrients and macronutrients was not influenced or interfered with in anyway.

4.2 Assessment of participant characterisation

According to the power calculation (page 41), 42 participants were required to gain possibly significant results, an extra 10% was accounted for to allow drop outs (n=46). A total of 47 participants were recruited and 100% compliance rate was achieved.

The mean age (table 3.1) is close to other studies investigating similar subjects. Mouratidou et al. (2006) mean subjects' age was 27, where as Haggarty et al. (2008) investigated participants with a mean age of 30 years. The age group for 27-30 year olds in this present study had the highest number of participants (figure 3.0).

The present study recruited people in their first or second trimester, as no women in their 3rd trimester attended these antenatal classes. However a study conducted by Sinikovic et al. (2007) recruited pregnant women from all trimesters. The present study could have benefited from including women in their final trimester as it could have given a more representative sample of pregnant women. Furthermore the present study would have been able to investigate if there were any significant results regarding nutritional knowledge and dietary intakes between all trimesters.

The present study included single participants, participants with partners and married participants. A study by Haggarty et al. (2008) established further groups for those women who reported having a partner, to investigate the level of partner support and its effects on dietary intake. Those women cohabiting tended to have better support and a

more adequate diet compared to those who had a partner but were living alone. This could have been applied to the present study to investigate any significant differences between women who stated having a partner.

Occupation was chosen to represent social class, as it was deemed less invasive, as participants may have felt uncomfortable reporting their income (Carstairs & Morris, 1989). Another possibility of deducing social class could have been to ask for participants for their present post code. A study by Carstairs & Morris (1989) investigated social class by analysing post codes and found a significant correlation between social class and post code ($p<0.05$).

Smokers were excluded from data analysis as there were only 4 in the study population. This could have resulted inaccurate results. A study conducted by Lagiou et al. (2005) included statistical analysis for smokers even though a small minority reported smoking (n=11/211), however no significance was established and bias was accounted for. In other studies, smokers during pregnancy have been included and significant results have been established between smokers and non smokers. Haste et al. (1990) found smokers had a significantly lower micronutrient intake compared to non smokers ($p=0.001$). Mathews et al. (2000) further found smokers had a significantly lower micronutrient compared to non smokers ($p<0.05$).

4.3 Nutritional knowledge of the importance of micronutrients and macronutrients during pregnancy and intakes

The present study used RNIs for pregnancy, set by COMA (1991). This was appropriate as some micronutrient requirements differ for pregnant women compared to non pregnant women (table 1.1)

Lagiou et al. (2005) did not use the RNIs set by COMA (1991), the study used RDAs set by Commission of the European communities (1993). Why these RDAs were used

was unclear as the study was carried out in Boston, USA. However the RDAs used did include adjustments where necessary for pregnant women.

4.3.1 Calcium

The majority of the study population achieved the RNI for calcium (figure 3.1), however less than half identified the correct RNI for calcium and possible birth defect caused by calcium deficiency such as, LBW (table 3.3). The majority correctly identified a main food source for calcium (97.9%); however this does not seem to be related to consumption.

The mean intake for calcium (788.6 ± 210.5 mg/day) for this present study differs to Mouratidou et al. (2006), as the mean calcium intake for pregnant women was 692 mg/day from his investigation. The present study's mean calcium intake is also very different to mean calcium intake (688 mg/day) for British females, aged 19 – 50 years, as the majority do not consume the RNI [700mg/day] (NDNS, 2004). A possible suggestion could be due to the increase in fortified products with calcium, such as breakfast cereals and breads.

Calcium intake in the present study is above the RNI however it is within a safe range and not near toxicity levels [2g/day] (Department of Health, 1991), which has been associated with calcification of bones and organs (Department of Health, 1991).

Low calcium intake during pregnancy has been associated with LBW (Sabour et al, 2006). A RCT involving 91 pregnant women recruited during the 20th week of gestation either received a daily supplement of 1.5 g calcium or a placebo. The study continued throughout the year after delivery. Infants were assigned into 2 groups, depending on whether their mother had received calcium supplementation or not. The study found that infant growth, mean weight and head circumference of infants born to calcium supplemented mothers were similar to those born to mothers who received a placebo.

On the other hand, mean length and mean mid arm circumference were significantly higher in the infants with calcium supplemented mothers. However no significant difference was recorded after 12 months. The study concluded that women with low calcium intake during pregnancy do not have a significant impact on foetal growth (Abdel-Aleem et al., 2009). This study did not investigate possible associations with low calcium intake during pregnancy and adulthood, which might have significant impact of bone mass and health (Earl et al., 2009).

4.3.2 Iodine

Mean iodine intake in the present study was 103.5 ± 48.1 µg/day; this is lower than the average consumption of British females, aged 19-50 years, in the UK who consume 130µg/day of iodine (NDNS, 2004). Mouratidou et al. (2006), found similar low mean iodine consumption among pregnant women (92.5 µg/day). The present study did not take into account added salt intakes consumed through diets. This could have increased iodine levels as salt tend to be fortified with iodine (Zimmermann, 2009).

Less than 20% of the study population achieved the RNI (140 µg/day) for iodine and less than 20% were able to correctly identify the correct RNI, key sources and possible birth defects caused by iodine deficiency such as cretinism. This could possibly suggest that a low knowledge regarding iodine may affect intake as people may be unaware of the importance of iodine and may not recognise key sources of iodine to consume

A review by Zimmermann (2009) found that those women consuming <120 µg/day day of iodine had inadequate iodine levels and could increase the risk of the infant being born with cretinism. Possibly suggesting women in the present study could also have an increased risk of their child being born with cretinism. However a study by Romana et al. (1991) carried out a RCT randomly assigning one group of pregnant women to receive 120 µg/day of iodine and the other group received a placebo. However no

significant difference was found and it was concluded that the risk of cretinism was not increased.

4.3.3 Iron

The mean food intake of iron, in the present study was 11.65 ± 3.1 mg/day, this figure is higher than the UK average of 8.8mg/day for females aged 19 – 50 years (NDNS, 2004). However it is lower than the RNI [14.8mg/day] (COMA, 1991). The mean intake of iron from the present study is also higher than the mean iron intake in other studies (Mouratidou et al., 2006; O'Shall, 2005). Mouratidou et al. (2006) used a FFQ to estimate dietary intakes; this could why lower mean iron intakes were obtained. Bingham et al (1993) concluded that FFQ can be less accurate than food diaries with estimated weights.

Allen (2001) suggested that low iron intake during pregnancy can result in anaemia. Anaemia during gestation may increase the risk of preterm births and increase the probability of the offspring being born with a less developed immune system and therefore increasing the risk of infections. Allen (2001) did not state what low levels of iron were, therefore it was not possible to relate risks to the present study. Mohamed et al. (1989) and Sloan et al. (2002) found that adequate iron intakes, similar to mean intakes in the present study, could increase serum ferritin, serum iron and bone marrow iron.

4.3.4 Zinc

In the present study as 80.9% of participants achieved the RNI for zinc. However according to data collection zinc was one of the least correctly identified minerals, in terms of RNI, food source and possible birth defects caused by zinc deficiency such as LBW (table 3.3). Possibly implying there may be no relationship between nutritional knowledge and intake.

The mean consumption for zinc was 9.2 ± 3.1 mg/day. This was higher than the RNI of 7.0 mg/day (COMA, 1991). A study by Lagiou et al. (2005) found that the majority of participants had a mean zinc intake higher than the RNI. Mean zinc intakes from the present study do not reflect mean values for British females, aged 19 – 50 years, who on average consume 6.8mg/day (NDNS, 2004). The RNI of zinc from the present study is also higher than that established by Mouratidou et al, (2006), who established a lower mean zinc intake of 7.4 mg/day.

Low levels of zinc intake have been associated with spontaneous abortion and congenital malformation such as, anencephaly, whereas moderately low levels of zinc intake have been associated with LBW (Caulfield et al., 1998). Research regarding moderately high zinc intakes during pregnancy is limited. However very high levels of zinc intake can be toxic and be detrimental to maternal and infant health (Caulfield et al., 1998).

4.3.5 Folate

Participants showed out of all micronutrients and macronutrients folate achieved the highest percentage of correctly identified answers for RNI, Main food sources and identifying possible birth defect caused by folate deficiency such as NTD (table 3.3). This was expected as the majority of information given to pregnant women is regarding the importance of folic acid intake. However the majority of participants did not consume the RNI for folate (300µg/day), possibly suggesting no relationship between nutritional knowledge and folate intake.

Mean folate intake, 246.4 ± 132.6 µg/day, for the present study population was below the RNI. This figure was unexpected as stated previously folic acid information is given to pregnant women, however it is important to bear in mind that more than 50% of pregnancies are unplanned in the UK (Department of Health, 2000). Other studies have

also found low mean folate intakes among pregnant women (Mouratidou et al. 2006; Koebnick et al., 2001). However Koebnick et al. (2001) further analysed the results and adjusted for dietary supplements and found the majority of participants achieved the RNI for folate. The present study did not account for dietary supplements; therefore participants might have achieved the RNI.

Overall participants had low folate intakes. Past studies have shown low folate intakes prior to conception and throughout gestation have been associated with NTD, such as spina bifida (Kadir & Ecomides, 2002; James & Miller, 1981; Mills et al., 1989). A case control study by Mosley et al. (2008) found that white, non Hispanic, pregnant women with a low dietary folate intake had an increased risk of giving birth to an infant with spina bifida (p=0.05). However Helmet et al. (2009) discussed how not all NTD can be prevented by folate supplementation but there has been a decreased number of infants born with NTD since folic acid fortification of foods and through dietary supplements (Mosley et al., 2008).

4.3.6 Vitamin A

Nearly all participants achieved the RNI of vitamin A through their diet, however only 8 participants could identify the RNI and 3 participants could correctly identify a possible birth defect caused by vitamin A deficiency, such as partially developed retina (table 3.3).

Mean vitamin A intake, 290.9 ± 163.2 µg/day, for the study population is just above the LRNI (250 µg/day) set by COMA (1991). This seems unlikely as the LRNI represents around 2.5% of the population. Lagiou et al. (2005) studied the diets of pregnant women and obtained a mean vitamin A intake of 2666.7 µg/day. However this included dietary supplements. The present study did not include the use of supplements, which may have increase mean vitamin A intakes.

A low vitamin A intake during pregnancy had been associated with impaired vision of the infant due to a less developed retina and LBW babies (Radhika et al, 2002). Radhika, et al. (2002) found low vitamin A status during pregnancy increased the risk of preterm delivery (p=0.02), anaemia (p=0.003) and night blindness was observed in 2.9% of women. However Radhika et al. (2002) analysed vitamin A status using biomarkers, which is a more accurate measure than food diary analysis (Crozier et al, 2006). Therefore it is unclear to state whether participants in the present study were at risk of developing these illnesses.

4.3.7 Vitamin C

Mean vitamin C intake (62.5 ± 35.3 mg/day) for the present study population is close to the intake for females, aged 19 – 50 years, who on average consume 67.9 mg/day in the UK (NDNS, 2004). However the accuracy of mean vitamin C intake is questionable because vitamin C is easily lost through different cooking methods. This present study did not account for different cooking methods. Other studies can relate to the present study's mean vitamin C intake, as mean vitamin C intake is higher than the established RNI for the study (Mouratidou et al., 2006; Lagiou et al. 2005).

Exposure to high vitamin C levels during pregnancy have shown to affect the body's ability to metabolise vitamin C and when vitamin C levels are reduced to normal intakes, this may cause a deficiency. However this is only applied to intakes 2000mg/day (New et al., 2000).

Lagiou et al. (2005) found positive associations with high intakes of vitamin C. In the cohort study those participants with a higher vitamin C intake gave birth to infants with a larger birth weight, birth length and larger head circumference; however these findings were not established as significant. Chappell et al. (1999) found those with

sufficient consumption of vitamins C resulted in a 21% (p=0.015) lower rate of preeclampsia and pregnancy induced hypertension.

4.3.8 Vitamin D

100% of participants did not consume the RNI of vitamin D for pregnant women (10µg/day). However the present study does not include the use of dietary supplements, which is how COMA (1991) recommends pregnant women to achieve the RNI (Hollis & Wagner, 2004). Also the study did not measure plasma 25OHD levels, which is influenced by ultraviolet light exposure and could increase vitamin D status (Namgung et al., 1993).

According to the NDNS (2004) the average consumption of vitamin D among females aged 19 – 50 years is 2.3 µg/day, in the UK; this is similar to intake in the present study. Mouratidou et al. (2006) also found a low vitamin D (2.6 µg/day) intake among the pregnant participants. Bowcott (2010) claims that low vitamin D status could be due to public health messages regarding protecting skin from ultra violet light in order to decrease cancer risks. However using excessive sunscreen prevents vitamin D being absorbed into the skin and therefore contributing to more people being at risk of becoming deficient in vitamin D. Bowcott (2010) offers another reason why vitamin D deficiency is rising in the UK, which is possibly due to people living more sedate lifestyle and spending more times indoors.

Low levels of maternal vitamin D status have been associated low BMD in offspring. A longitudinal study investigated 198 children born in 1991-92 in a hospital in Southampton, UK. Maternal vitamin D status was recorded throughout gestation. The children were followed 9 years later so BMD could be analysed. 31% of mothers had insufficient and 18% has deficient circulating concentrations of 25 OHD during late pregnancy. This was associated with their children having a reduced whole body BMD

(p=0.008) and lumbar spine BMD [p=0.03] (Javaid et al., 2006). However this study only investigated association during the final trimester therefore it is unclear if low vitamin D status during early pregnancy will have the same effect.

4.3.9 Omega 3 fatty acids

The mean intake for n-3 fatty acids, 243.0 ± 209.4 mg/day, is below the RDA set by ISSFAL (1991). This could possibly be explained as the majority of participants could not correctly identify the RDA and a possible birth defect caused by n-3 fatty acids deficiency such as impairment of neurodevelopment (table 3.3). However, this figure is higher than the average of 180 mg/day by British females, aged 19 – 50 years (NDNS, 2004). Bonham et al. (2008) investigated the diets of pregnant women and found a high mean n-3 fatty acid intake (73.2 g/day). High n-3 fatty acids intake was accounted for because the study took place on a small island (Seychelles) where fish is a major dietary source. However main land studies, such as Sinikovic et al. (2007), investigated pregnant women attending antenatal classes in South Wales, Australia and found that participants (n=190) had a low n-3 fatty acids intake and concluded that this may be related to the fact that only 23% of participants had received information regarding n-3 fatty acids.

Nutrient interactions were important to consider as a randomised double blind control trial by Estchmann et al. (2007) involved over 300 pregnant women who received either 400 µg/day of folate, 0.5 g/day DH and 0.15 g EPA or a placebo. The study concluded that folate supplementation during pregnancy through to delivery improved foetal LC n-3 PUFA status and significantly helps prevent depletion of maternal stores (p=0.046). However pregnancy outcomes were not significantly affected. However in the present study folate levels were low, this could have affected n-3 fatty acid absorption. This information is not obtainable from the present study as biomarkers were not used.

4.3.10 Nutritional knowledge and age group

No significant difference was found between nutritional knowledge and age group, however the hypothesis is not completely opposed as the older age groups (31-37 years) did perform better on the questionnaire compared to the youngest age group (22-26 years). A study conducted by Rastogi et al. (2010) also found no significant difference between age and nutritional awareness during pregnancy. However past studies have suggested younger age groups tend to know less about adequate nutrition during pregnancy compared to older age groups (Mathews et al., 2000 & Sen et al., 2001). Sen et al. (2001) conducted a study on pregnant women attending antenatal classes and found that women, aged 30 years and older had a better understanding of adequate nutrition during pregnancy especially in relation to folic acid ($p < 0.05$).

4.3.11 Nutritional knowledge and marital status

No significant difference was found between nutritional knowledge and marital status as past studies have suggested (Sen et al., 2000 & Hilton, 2007). Sen et al. (2001) concluded married women had a significantly higher knowledge of adequate nutrition during pregnancy especially regarding folic acid ($p < 0.01$). Overall, in this study, married women performed better on the questionnaire than single women and women who had a partner. Sen et al. (2000) further stated that married women were more willing to learn.

4.3.12 Nutritional knowledge and occupation group

A significant difference was found between knowledge and occupation group ($p=0.009$). This significant result agrees with the hypothesis that those with a higher skilled occupation have a significantly better understanding of adequate nutrition during pregnancy compared to those with a lower skilled occupation. Very few studies have investigated occupation and nutrition awareness during pregnancy. Therefore in this present study occupation is a representation of social class. Sen et al., (2001) investigated social class and nutrition awareness during pregnancy. The study agreed with the findings from this paper as participants in the highest social classes were significantly more aware of adequate nutrition during pregnancy ($p < 0.01$). This result was similar for Sinikovic et al. (2007) who further found a significant difference between knowledge and social class ($p<0.05$).

4.3.13 Nutritional knowledge and trimester

The hypothesis that women in the second trimester group will have a greater knowledge regarding the importance of diet during pregnancy than those in the first trimester group is not significantly supported. However the second trimester group had the highest number of people in the high scoring group. Limited research has been conducted on the topic, however past studies have found that women in their first trimester are more eager to learn about adequate nutrition during pregnancy than in any other trimester (Alwan et al. 2010; Szwajcer et al. 2006).

4.3.14 Nutritional knowledge and number of previous pregnancies

Those women who had had one or more previous pregnancy achieved the highest scores from the questionnaire compared to those who had had no previous pregnancies.

Sinikovic et al. (2007) found those women who already had one or more children knew significantly more about adequate nutrition during pregnancy compared to those who were pregnant for the first time ($p<0.05$). However this information was mainly regarding n-3 fatty acids; therefore the results from the study can be totally applied to the present as study as nutritional knowledge may differ for other minerals and vitamins.

4.4 Mean dietary micronutrient and macronutrient intake and age group

The older age group (31 – 37 years) tended to have higher mean intakes than those in the younger age groups. Haggarty et al. (2008) reported age at delivery was a factor associated with deprivation, in terms of diet during pregnancy and was further associated with LBW, preterm delivery (< 37 weeks) and neonatal treatment ($p=0.012$). Mathews et al (2000) found that for most nutrients included in their study, intakes increased drastically with age. For example vitamin C intake increased 16% ($p=0.001$) and iron increased by 9% ($p=0.001$) for every 5 year increase in maternal age. Folate, vitamin A, zinc and calcium intake also significantly increased with age ($p=0.001$). Mathews et al. (2000) further stated that in their study age was the most significant predictor of nutrient intake. Hilton (2007) further found than age influences nutritional knowledge during pregnancy ($p<0.05$). Older participants were more eager to learn about nutrition requirements during pregnancy.

This present study may not have achieved a significant result for age and dietary intake due to a small population size (n=47). Even though this present study was adequately powered to achieve significant results, other studies have included a much larger population of over 700 participants (Mathews et al., 2000 & Haggarty et al., 2008), which may increase the chance of gaining significant results.

4.4.1 Associations between mean dietary micronutrient and macronutrient intake and age

A positive correlation was found between mean dietary micronutrients (folate and vitamin C) and macronutrients intakes (Omega 3 fatty acids) and age. R=0.0334, this was defined as a 'low positive correlation' (Cohen & Holliday, 1996). Even though a low positive correlation was found, the results still stood as significant as the P value was smaller than 0.05.

4.5 Mean dietary micronutrient and macronutrient intake and marital status

The hypothesis that married women will have a higher mean micronutrient and macronutrient intake is rejected and the null hypothesis is supported because single women tended to have the highest nutrient intakes (table 3.10), however results did not reach significance. The null hypothesis being supported could be due to group sizes not being equal, which could have affected the results by causing bias.

Past studies have concluded that married women tend to have a more adequate and nutrient dense diet during pregnancy. Haggarty et al. (2008) found that those women with the better quality diet were married and their diets were twice as nutrient dense than single women. Bennet (1992) found that married women had better nutritional intakes than single pregnant women. Bennet (1992) further concluded that married pregnant women have better infant health outcomes than single mothers.

4.6 Mean dietary micronutrient and macronutrient intake and occupation group

The hypothesis that those with a more skilled occupation will have a greater mean micronutrient and macronutrient intake is supported for some. Mean iron intake was significantly higher in the more skilled occupation group ($p<0.05$) as was mean calcium intake [$p=0.004$] (table 3.11). Overall the more skilled group tended to have the highest

mean intakes of nutrients. Interestingly mean iron intake for the skilled group (12.6 ± 3.0) did not meet the RNI for the mineral; this may be due to all occupation groups not being aware of how much iron they should be consuming.

Haste et al. (1990) and Schofield et al. (1989) found that those in a lower social class, therefore those with a less skilled job, had significantly lower intakes of micronutrients and macronutrients ($p<0.05$). However like this present study information regarding dietary supplements are unavailable, which might have affected results.

Mosley et al. (2008) found that dietary intake especially folate intake was affected by social class. Those participants in lower social classes had significantly lower folate intakes than those in higher social classes ($p<0.05$) and had an increased risk of giving birth to an infant with NTD. Further support that occupation (social class) may affect mean nutrient intakes comes from Perry and colleagues (1995) found that low iron status was significantly lower for pregnant women with a low income compared to those pregnant women with a higher income ($p=<0.05$).

4.7 Mean dietary micronutrient and macronutrient intake and trimester

The hypothesis that those women in a later trimester will have a greater mean dietary micronutrient intake (including calcium, iodine, iron, zinc, folate, vitamin A, vitamin C and vitamin D) and macronutrient intake (Omega 3 fatty acids) than those in their first trimester is significantly supported ($p=0.008$). This could be partially explained by the growing foetus increasing hunger and energy requirements (Department of Health, 1991). Anderson (2001) found that pregnant women in later trimesters had significantly higher vitamin and mineral intake than women in their first trimester ($p<0.05$). A further study investigating mean nutrient intakes and trimester found that those women in their first trimester had significantly lower vitamin D levels compared to those in later trimesters [$p=0.001$] (Holmes et al., 2010).

Scholl (2005) reviewed studies involving iron intake during pregnancy. One study explained how low iron intakes throughout pregnancy results in anaemia. The study found that anaemia increased >4 fold from the first trimester through to the third trimester (Perry, Yip & Zyrkowski, 1995). Scholl (2005) further reports the Camden study also found a significant difference in iron intake across the trimesters. A 6 fold increase was established, from 6.7% of pregnant women having anaemia in first trimester, to 27.3% of pregnant women having anaemia in second trimester, to 45.6% of pregnant women having anaemia in third trimester.

4.8 Mean dietary micronutrient and macronutrient intake and number of previous pregnancies

The hypothesis that those participants with a higher number of previous pregnancies will have a greater mean micronutrient and macronutrient intake is significant for mean vitamin C consumption ($p=0.025$), however no other significant results were established for other micronutrients and macronutrients. Overall those participants with one or more previous pregnancies tended to have higher mean intakes for 75% of the micronutrients and macronutrients included in this study (table 3.13). However research by Bogner & Siega Riz (2001) found that those women who had had one or more previous pregnancies tended to have to lower mean nutrient intakes than those who had not had any previous pregnancies($p<0.05$).

Interestingly mean calcium intake was highest in those participants who had not had any previous pregnancies. This was unexpected because past research by Olausson et al (2008), suggested that those women who had had previous pregnancies should have higher calcium intake to account for BMD loss. It could be suggested that participants in this present study were possibly not informed of this information and therefore did not intentionally consume more calcium.

Other previous research carried out by Haggerty et al. (2008) found that women who have had multiple previous pregnancies are at greater risk of LBW babies, preterm births [<37 weeks] ($p=0.001$) and requiring neonatal treatment ($p<0.001$). This suggests women who have had multiple previous pregnancies need to ensure they have an adequate and nutrient dense diet during pregnancy.

4.9 Limitations

Previous studies have investigated women purposely changing their diets and seeking dietary advice during pregnancy (Anderson et al, 1993; Hall et al, 1985 & Szwajcer et al, 2006). However this study failed to take this factor into consideration, therefore it is unclear if food diary records are due to a continuation with normal eating habits or if participants have purposely changed their diet. This information would have been especially appropriate for this study as Anderson (2001) points out those women attending antenatal classes receive education regarding the benefits of a healthy and adequate diet during pregnancy and staff are trained to inform advice and re-enforce health messages regarding nutrition. Therefore it would have been interesting to investigate whether or not participants follow advice given to them by health professionals. Hall et al (1985) found that 94% (n=155/165) of pregnant women claimed to have read about nutrition during pregnancy.

It is of extreme importance to accurately monitor maternal consumption of foods and nutrients, including dietary supplements in order to achieve true intakes. Dietary supplements and fortified food consumption are on the rise therefore it is a necessity to record (Ortiz- Andrellucchi, Doreste-Alonso, Henriquez-Sanchez, Cetin & Serra-Majem, 2009). However this study did not account for supplement use, therefore mean intakes are solely based on dietary intakes. This may have affected accuracy of results.

The study failed to include nutritional knowledge of vitamin D. Vitamin D could have been important to investigate as the prevalence vitamin D deficiency is increasing in the UK.

4.10 Implications for future research

The present study could be applied to future research and future practise as it has exhibited that pregnant women may require further information regarding adequate nutrition during pregnancy, especially pregnant women who are in their early 20s, who have a low income and those women who are going to be first time mothers.

Many pregnant women first go to see their doctors once they find out they are pregnant. Therefore it is extremely important that doctors can give out adequate information regarding pregnancy and nutrition. It is also vital that doctors are able to inform patients of the dangers associated with poor diets and smoking during pregnancy. It is important to remember the lifelong risks associated with inadequate nutrition during pregnancy such as CVD, diabetes and low BMD. Therefore it is vital that doctors and midwives are able to inform patients and ensure everything possible is being done to achieve adequate nutrition during pregnancy.

Antenatal clinics is a significant situation to use the present research project as antenatal classes are able to reach a large amount of pregnant and should be able to ensure pregnant women understand and are fully aware of adequate nutrition during pregnancy.

5.0 Conclusion

It was concluded from this study that intakes of key micronutrients and macronutrients during pregnancy do not reflect the understanding of specific micronutrients and macronutrients, as no significant results were found for this hypothesis. The participants from this study possess a sound understanding of food sources for the different micronutrients and macronutrients. However it appears that this does not influence dietary intake, as RNIs in general were lower than recommended.

It is apparent from this study that occupation does have an effect on knowledge and mean nutrient intakes. Those in the higher skilled occupation groups generally had the highest significant mean intakes of nutrients and performed significantly better on the questionnaire. Furthermore it is apparent that trimester and numbers of previous pregnancies affects mean nutrient intakes. Those participants in their second trimester and those women with one or more previous pregnancies had a more adequate diet than their counterparts.

It is noticeable that the participants understand the relationship between some nutrient deficiencies and possible birth defects. Participants were most aware of folic acid deficiency and the relationship with NTD. However few participants achieved the RNI for folic acid and many other essential nutrients, suggesting pregnant women require further knowledge regarding how to obtain certain nutrients from their diets.

It is evident from the research that participants require additional information regarding the importance of iodine, iron, folate, vitamin A, vitamin D and n-3 fatty acid intakes during pregnancy. However it is plausible to assume that the participants from this research project do not need further information regarding calcium, zinc and vitamin C intakes as adequate intakes were achieved.

This study could impact future practice by raising awareness of the importance of adequate nutrition during pregnancy and by ensuring health professionals provide more education and guidance on nutrition and more education on birth defects possibly caused by nutrient deficiencies.

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7.0 Appendices

7.1 Letter of invitation to participants and participant information sheet

7.2 Consent form

7.3 Food diary

7.4 Questionnaire

7.5 Letter to relevant personnel

7.6 Letter from relevant personnel

7.7 Tables to show number codes for SPSS

7.1 Appendix 1: Letter of invitation to participants and participant information sheet

Dear Mrs/Miss

I am a student from the University of Chester conducting a study in your antenatal clinic; I would like to invite you to take part. Our study aims to investigate the diet of pregnant women and to investigate knowledge of dietary needs. Before you decide, it is important for you to understand why the research is being carried out and what it will involve. Please take time to read the following information overleaf carefully, and discuss it with others if you wish. You can ask me if there is anything that is not clear or if you want more information. Please take time to decide whether or not you wish to take part.

If you wish to participate please complete the consent form and hand it in to the researcher. Then you will be given further information regarding the next stage.

Thank you for your time and I hope to hear from you soon.

Kind regards

Lindsey Currie

Participant information sheet

Are the key dietary recommendations met and understood during pregnancy among pregnant women.

What is the purpose of the study?

The study will investigate whether recommended amounts of vitamins, minerals and fats are met during pregnancy and to assess knowledge of the vitamins, minerals and fats.

Why have I been chosen?

You have been chosen because you are a pregnant woman aged between 19-50 years.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you are still free to withdraw from the study at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive in any way.

What will happen to me if I take part?

If you decide to take part, you will be given this information sheet to keep and asked to sign the consent form. The next stage will involve the recording of a 3 day food diary and the completion of a questionnaire. No participant will be identifiable in the final report. The filling in of the questionnaire should take no longer than 10 minutes and the 3 day food diary should take no longer than 10 minutes each day to fill in. Overall around 40 minutes of your time will be required to complete the study.

What are the possible disadvantages and risks of taking part?

There are no disadvantages or risks foreseen in taking part in this study.

What are the possible benefits of taking part?

By taking part in this study you will be contributing to research and knowledge in this subject area.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact: Dean of the Faculty of Applied and Health Sciences, Professor Sarah Andrew at s.andrew@chester.ac.uk or telephone 01244 513055.

Will my taking part in the study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential so that only the researcher carrying out the research will have access to such information. You will not be identifiable as identification numbers will be used instead of names. All electronic copies will be protected with passwords and hard copies will be securely stored so that only the researcher will have access to these information.

What will happen to the results of the research study?

The results will be written up into a report. It is hoped that the findings may be used to improve the nutritional intake of women during pregnancy and preconception. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising and funding the research?

The research is organised by a public health nutrition (MSc) student. The University of Chester will fund the study.

Who may I contact for further information?

If you would like more information about the research before you decide whether or not you would be willing to take part please email: 0914805@chester.ac.uk or email: s.mushtaq@chester.ac.uk (supervisor).

Thank you for your interest in this research.

7.2 Appendix 2: Consent form

Consent form

Title of Project: Are the key dietary recommendations met and understood during pregnancy among pregnant women.

Name of Researcher: Lindsey Currie

1. I confirm that I have read and understood the participant information sheet, dated ……., for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my care or legal rights being affected. ☐
3. I agree to take part in the above study. ☐

Signed……

Print name …….

I.D number ……..

7.3 Appendix 3: Food diary

Food Diary

I.D. Number _____

Instructions

- Write down everything you eat and drink over 3 days, preferably 2 week days and 1 weekend day. This is to allow a true representation of your diet.
- Please include as much information as you can. For example weights of the food if known or household measurements can be used such as tablespoon and teaspoon. This is to allow a more accurate analysis.
- Please use brand names where possible
- Please ensure you include all extras such as mayonnaise and ketchup.

Example of the Food diary

Food item/Drink	**Quantity**
Cup of tea with semi skimmed milk	50 ml milk
Special K cereal	50 grams
Milk	150 ml
Water	Large glass
Apple	Large
Hovis brown bread	2 pieces
Tuna	Half a tin
Mayonnaise	1 tablespoon
Cucumber	3 cm
Water	Large glass
Rocky biscuit	1
Cup of tea with semi skimmed milk	50 ml milk
Juice	Large glass
Tuna steak	1 large
Spinach	Handful
Aubergine	Handful
Juice	Large glass
Hot chocolate with semi skimmed milk	300ml milk, 3 tbs hot chocolate

Food diary Day 1

Day: …….

Food item/Drink	**Quantity**

Food diary Day 2

Day: …….

Food item/Drink	**Quantity**

Food diary Day 3

Day: …….

Food item/Drink	**Quantity**

7.4 Appendix 4: Questionnaire

Questionnaire

Instructions

- Please fill in as many answers as possible.
- The questionnaire will require a written answer or for an appropriate option to be circled.
- Questions 14 – 19 require one answer to be circled for each different vitamin or mineral

1) I.D. number _____

2) Date of Birth:

3) Weight: Stone Pounds or Kg

4) Height: Feet Inches or Metres Centimeters

5) Marital status:

Single Partner Married Other ……

6) Current occupation:

Professional Management and technical Clerical and minor supervisory

Skilled manual semi-skilled manual unskilled manual

Other……..

7) Do you smoke:

Yes No

8) Number of weeks into pregnancy:_____

9) Number of previous pregnancies:_____

10) Do you know the recommended intake each day for the following minerals and vitamins during pregnancy (please circle one answer for each mineral and vitamin):

Minerals

Calcium:	200mg	500mg	700mg	1000mg	Don't Know
Iodine:	110µg	120µg	130µg	140µg	Don't know
Iron:	2.5mg	14.8mg	20mg	100mg	Don't Know
Zinc:	5.0mg	6.0mg	7.0mg	8.0mg	Don't know
Vitamins					
Folate:	200µg	300µg	400µg	500µg	Don't know
Vitamin A:	600µg	700µg	800µg	900µg	Don't know
Vitamin C:	30mg	40mg	50mg	60mg	Don't know

11) Do you know the major sources of the following minerals and vitamins (please circle one answer for each mineral and vitamin):

Minerals

Calcium:	Crisps	Cheese	Bacon	Pasta	Don't Know
Iodine:	Chips	Cucumber	Tuna	Rice	Don't know
Iron:	Mushrooms	Crisps	Beef	Pasta	Don't Know
Zinc:	Honey	Bread	PotatoesEggs	Don't know	
Vitamins					
Folate:	Marmite	Cheese	Butter	Chicken	Don't know
Vitamin A:	Mango	Turkey	Ham	Chocolate	Don't know
Vitamin C:	Lamb	Orange	Noodles Prawns	Don't know	

12) Do you know the recommended intake each day for omega 3 fat during pregnancy (please circle one answer):

Omega 3 fat:	300mg	350mg	400mg	450mg	Don't know

13) Do you know the major sources of omega 3 fat (please circle one answer):

Omega 3 fat:	Fish	Sausage	Gravy	Lettuce	Don't know

14) Do you know any possible pregnancy outcomes for the baby that may be associated with the following mineral and vitamin deficiencies, if yes please write down your answer in the space provided:

Minerals

Calcium deficiency: ……

Iodine deficiency: ……..

Iron deficiency: ……

Zinc deficiency: ……..

Vitamins

Folate deficiency: ……

Vitamin A deficiency: ……

Vitamin C deficiency: ……

15) Do you know any possible pregnancy outcomes for the baby that may be associated with the following omega 3 fat deficiencies, if yes please write down your answer in the space provided:

Omega 3 fat deficiency: ……

Thank you for completing the questionnaire

University of Chester

Antenatal clinic
Address line 1
Address line 2
Postcode

To Whom It May Concern:

My name is Lindsey Currie and I am a MSc student studying public health nutrition at the University of Chester. Completion of the MSc requires a dissertation therefore I am writing to you to request consent to undertake a non invasive research project at the antenatal clinic, and enquire as to the possibility of gaining access to your patients to achieve this?

The study will investigate whether the Reference Nutrient Intakes (RNI) for key micronutrients and macronutrients set by COMA (Committee On Medical Aspects, 1991), are met during pregnancy. The study will further assess understanding of key micronutrients and macronutrients, among pregnant women in Liverpool.

This will be achieved by firstly issuing food diaries to any interested volunteers in order to gain an understanding of their usual diet and analysing these to see if key micronutrients and macronutrients meet the RNI's. This will be followed by a short questionnaire regarding key micronutrients and macronutrients required for gestation. An example of the food diary and questionnaire are attached.

The study aims to raise awareness of the importance of key micronutrients and macronutrients required during pregnancy.

I am looking to conduct the study during October 2010. If this date is not suitable for you, could you please suggest another time period that is more suitable?

If you feel this is possible and you wish to help conduct this important study, please contact me at the address above or phone with your reply.
I look forward to hearing from you.

Yours Sincerely,

Lindsey Currie

7.6 Appendix 6: Letter from relevant personnel

6 October 2010

Dear Lindsey,

Thank you for completing the application form regarding recruitment of participants f your study.

I am pleased to confirm that ethical approval has been granted and you hav permission to carry out your study.

You will receive a letter in a few days regarding information about the antenat classes, including the address, time and date.

Kind Regards,

Mary Newburn

Head of Research and Information

NCT

7.7 Appendix 7: Tables to show number codes for SPSS spreadsheet

Table 7.7.1 Table to show number codes for age categories

Age categories (years)	Number codes
22-26	1
27-30	2
31-37	3

Table 7.7.2 Table to show number codes for marital status

Marital Status	Number code
Single	1
Partner	2
Married	3

Table 7.7.3 Table to show number codes for occupation group

Occupation group	Number code
professional, management and technical and clerical and minor supervisory	1
skilled manual and semi skilled manual	2
Unskilled manual, housewife and unemployed	3

Table 7.7.4 Table to show number codes for smokers

Smokers	Number code
Yes	1
No	2

Table 7.7.5 Table to show number codes for trimester

Trimester	Number code
1	1
2	2

Table 7.7.6 Table to show number codes for number of previous pregnancies

Number of previous pregnancies	Number code
No previous pregnancies	1
One or more previous pregnancies	2

Table 7.7.7 Table to show number codes for answers to knowing the RNI of calcium

RNI calcium (mg)	Number code
700 (correct)	1
200	2
500	3
1000	4
Don't know	5

Table 7.7.8 Table to show number codes for answers to knowing the RNI of iodine

RNI iodine (µg)	Number code
140 (correct)	1
110	2
120	3
130	4
Don't know	5

Table 7.7.9 Table to show number codes for answers to knowing the RNI of iron

RNI iron (mg)	Number code
14.8 (correct)	1
2.5	2
20	3
100	4
Don't know	5

Table 7.7.10 Table to show number codes for answers to knowing the RNI of zinc

RNI zinc (mg)	Number code
7 (correct)	1
5	2
6	3
8	4
Don't know	5

Table 7.7.11 Table to show number codes for answers to knowing the RNI of folate

RNI folate (µg)	Number code
300 (correct)	1
200	2
500	3
400	4
Don't know	5

Table 7.7.12 Table to show number codes for answers to knowing the RNI of vitamin A

RNI vitamin A (µg)	Number code
700 (correct)	1
600	2
800	3
900	4
Don't know	5

Table 7.7.13 Table to show number codes for answers to knowing the RNI of vitamin C

RNI vitamin C (mg)	Number code
50 (correct)	1
30	2
40	3
60	4
Don't know	5

Table 7.7.14 Table to show number codes for answers to knowing the RDA of n-3 fatty acids

RDA n3 fatty acids (mg)	Number code
300 (correct)	1
350	2
400	3
500	4
Don't know	5

Table 7.7.15 Table to show number codes for answers to knowing the food sources of calcium

Food source of calcium	Number code
Cheese (correct)	1
Crisps	2
Bacon	3
Pasta	4
Don't know	5

Table 7.7.16 Table to show number codes for answers to knowing the food sources of iodine

Food source of iodine	Number code
Tuna (correct)	1
Chips	2
Cucumber	3
Rice	4
Don't know	5

Table 7.7.17 Table to show number codes for answers to knowing the food sources of iron

Food source of iron	Number code
Beef (correct)	1
Mushrooms	2
Crisps	3
Pasta	4
Don't know	5

Table 7.7.18 Table to show number codes for answers to knowing the food sources of zinc

Food source of zinc	Number code
Potatoes (correct)	1
Honey	2
Bread	3
Eggs	4
Don't know	5

Table 7.7.19 Table to show number codes for answers to knowing the food sources of folate

Food source of folate	Number code
Marmite (correct)	1
Cheese	2
Butter	3
Chicken	4
Don't know	5

Table 7.7.20 Table to show number codes for answers to knowing the food sources of vitamin A

Food source of vitamin A	Number code
Mango (correct)	1
Turkey	2
Ham	3
Chocolate	4
Don't know	5

Table 7.7.21 Table to show number codes for answers to knowing the food sources of vitamin C

Food source of vitamin C	Number code
Orange (correct)	1
Lamb	2
Noodles	3
Prawns	4
Don't know	5

Table 7.7.22 Table to show number codes for answers to knowing the food sources of n3 fatty acids

Food source of calcium	Number code
Fish (correct)	1
Sausage	2
Gravy	3
Lettuce	4
Don't know	5

Table 7.7.23 Table to show number codes for answers to knowing a deficiency of calcium, iodine, iron, zinc, folate, vitamin A, vitamin C and n3 fatty acids

Deficiency of calcium, iodine, iron, zinc, folate, vitamin A, vitamin C and n3 fatty acids	Number code
Correct	1
Incorrect	2

Table 7.7.24 Table to show number codes for consuming RNI of calcium, iodine, iron, zinc, folate, vitamin A, vitamin C and RDA of n3 fatty acids

Consumed RNI calcium, iodine, iron, zinc, folate, vitamin A, vitamin C and RDA n3 fatty acids	Number code
Consumed RNI/RDA	0
Did not consume RNI/RDA	1

Table 7.7.25 Table to show number codes for score groups

Score group	Number code
Low (0-7)	1
Medium (8-10)	2
High (11-24)	3